THE

ELECTRICAL REVIEW.

VOL. XXXV. OCTOBER 12, 1894. No. 881

CONTENTS:

	PAGE
The Pacific Cable	425
Cheap Electric Light	426
The Berlin Electrical Works (*illustrated*)	427
Modification of Anderson and Kennelly's Method of Localising a Fault by the "Earth Overlap Test" (*illustrated*)	427
The Edison Feeder and Main Patent	428
Standard Units of Electrical Measurement.—III. (*illustrated*)	429
Correspondence:—Aeronautics	431
The Electric Motor and Some of its Applications	431
Vacuum Tubes	431
The Volt	431
Notes	432
Business Notices, &c.	435
The Electric Motor and Some of its Applications (*illustrated*) (*concluded*)	437
Electric Lighting at Worcester (*illustrated*)	441
Contracts Open and Closed	448
City Notes, &c.	448
Traffic Receipts	448
Share List of Electrical Companies	449
Duplex Telephony (*illustrated*)	450
On Persistent Electric Oscillations and their Effects (*illustrated*)	452
Notes on the Steam Turbine (*illustrated*) (*continued*)	453
Reviews:—Electric Lighting Plants: Their Cost and Operation	454
A Practical Treatise on Patents, Trade Marks and Designs	454
Electrical Engineering Leaflets	454
Thermo-dynamics of Reversible Cycles in Gases and Saturated Vapours	455
The Fatal Accident at Bankside	455
Electrical Standards (*illustrated*)	455
New Patents	456
Abstracts of Published Specifications	456

THE
UNIVERSAL ELECTRICAL DIRECTORY
(J. A. BERLY'S).

PRICE 4/- POST FREE.
The Leading Electrical Trades Directory and the Oldest Electrical Directory in the World.

1895 ISSUE NOW IN PREPARATION.

PRICE 4/- POST FREE.
Fully Revised and Thoroughly Reliable.
Contains a larger amount of Trade Matter than any other Electrical Directory.

H. ALABASTER, GATEHOUSE & CO.,
22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address: "AGENKAY, LONDON." Code A B C. Telephone No. 517
ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free, per Year, 19s. 6d. To all *Foreign Countries* (except those mentioned below), per Year, £1 1s. 6d. *Exceptions.*—Abyssinia, Aden, Borneo, Ceylon, India, Java, Labuan, Mozambique, Penang, Persia (*viâ* Brindisi), Phillipine Islands, Singapore, Zanzibar, to which the rates are: per Year, £1 8s, 10d.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

FOREIGN AGENTS.—*New York:* D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 23, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payabl to Mr. H. ALABASTER 22, Paternoster Row, E.C.

THE PACIFIC CABLE.

WE have been favoured with a copy of the proceedings of the Colonial Conference recently held at Ottawa for th purpose of considering the trade relations existing between Canada and the different colonies of Australasia, and the best means of extending the same, and of securing the construction of a direct telegraph cable between these colonies and the Dominion of Canada.

A good deal of the contents of this volume has already been published, the chairman of the Conference having been authorised by his colleagues to supply the Press with such information as to the proceedings as he thought they ought to receive.

Our views on the Pacific cable scheme have for some years past been very decided. We have not dealt so much with the financial side of the question, but we have always stoutly maintained that communication between Australasia and Canada *viâ* the Pacific was perfectly practicable at no unreasonable cost, and so we do not hesitate to frankly admit that a careful perusal of the lengthy arguments brought forward by the various delegates has left us with the impression that a good deal of preliminary work has yet to be done before the accomplishment of this great scheme is well within touch. Unfortunately strategical and commercial interests clash considerably. Colonial authorities seem to regard it as a *sine quâ non* that the cable should land at no place which is not entirely English, and while no one can doubt that this would be of the highest importance in the event of an European war, it seems a little strange that, as the Hon. Mr. Playford pointed out, no Imperial officer fitted by his position and knowledge to express an opinion has dealt with the matter. Colonials are naturally more alive to their interests than perhaps the Imperial Government is, but if these so-called strategical advantages were so great as they are represented to be, it is a little hard to understand why they have not been officially recognised before now.

At the Imperial Conference held at Wellington in 1887, a route for the cable was recommended which made Samoa and Honolulu both landing places, and neither of these are British. Since that time, however, the situation has changed, and a French company has stepped on the scene, and under guarantees from the Colonies of New South Wales and Queensland, as well as from the French Government, have laid a cable from Queensland to New Caledonia, thus securing landing rights in Australia for a rival French-American-German Pacific Cable.

Of the intermediate landing places which would naturally be selected from a commercial point of view, the most important is, perhaps, Honolulu. In 1893 no fewer than 310 merchant ships called there, and 13 men-of-war. With telegraphic communication it would no doubt become an impor-

tant trading centre. Leaving it out means either Neckar Island, which is described as unsuitable—no water, no grass, no trees; besides belonging to Hawaii—or a long stretch of over 3,500 miles from Vancouver direct to Fanning; another unsuitable landing, but fortunately British. As Mr. Walker, the Secretary of Telegraphs for New South Wales has pointed out, such a length as this means a very heavy and expensive core. By-the-way, one delegate seemed to think that the price of a mile of telegraph cable was immediately dependent on the price of copper, and perhaps there is some excuse for mixing up telegraph cables with electric light leads, when one hears cores of 940/940 spoken of.

We must say that we think we are justified in being disappointed at the results of the Ottawa Conference. It is always easy to be wise after the event, but it seems to us that before it met the Governments should have arranged among themselves and equipped and sent out a small suitable steamer, such as could readily be found at either end of the proposed line, with a competent telegraph engineer on board, to report on the proposed landing places, and take the soundings necessary to enable a definite route to be approximately selected. The cost of such a preliminary survey would perhaps have been about £10,000.

The route being decided on by the Conference, arrangements could have been made for a complete survey, and this effected, the necessary lengths and designs of types could be definitely decided on, and satisfactory tenders obtained from various contractors.

As it is now, the Governments do not know where they want their cables laid, and contractors who tender can have but approximate ideas of what types and lengths are necessary. The results do not seem to us likely to be very valuable, or to lead to any immediate business. On the other hand, the position of the rival scheme is a far simpler one. The 800 miles of cable to New Caledonia are self-supporting. From here to Fiji is 700 miles, Fiji to Samoa, where landing rights and a small subsidy are secured, we believe, is 643 miles. From Samoa to Honolulu is a stretch of 2,290 miles, and from thence to San Francisco another 2,090 miles. Thus the uncompleted distance by this route measures but 5,723 miles overground, and perhaps means some 6,290 miles of cable. A considerable part of the distance has been fairly sounded by American men-of-war.

CHEAP ELECTRIC LIGHT.

A PAPER by H. Ebert, which we summarise in another column, containing an account of some interesting experiments on the production of light by high frequency currents, deserves the careful consideration of electrical engineers. Ebert has made several very important improvements in the production and application of these currents, usually associated with the name of Tesla, and has, moreover, arrived at a rough estimate of the efficiency of this system of electric lighting which may possibly point the way to a revolution in our present methods. Others have gone nearly as far, but we do not know that "resonance" has been so completely made use of in any previous work.

We fear it must be admitted that the electric light, as at present produced, has no prospect, as far as regards cost of production, of competing with gas or oil. Its numerous advantages in other respects will no doubt lead to its extensive use, even though its cost should continue to be greater than that of gas lighting; but there can be no doubt that if any notable reduction was made in its cost, it would not take long to beat its rivals out of the field.

There can be little hesitation in pointing out the part of the electric light installation in which there is most need and most hope of increased efficiency. The dynamo has already so high an efficiency that little improvement is possible, and any great increase of efficiency in the conductors is equally out of the question. With the lamp, however, the case is different. It is not generally realised, we imagine, how wasteful of energy are our most efficient sources of light. Even in the arc lamp but a very small percentage of the total energy is given out as light. Langley has shown that in the ordinary Argand burner gas flame over 99 per cent. of the radiant energy is wasted, as far as illumination is concerned.

In some very instructive experiments made on the light emitted by the firefly, by Langley and Very, in 1890, it was shown that Nature, in this instance, had succeeded in producing light without heat, and could produce it, at one four-hundredth the cost in energy at which it was produced in the candle flame, and at an insignificant fraction of the cost at which it was produced in the electric light.

The great waste of energy in our artificial lights is due to the enormous proportion of heat. In the "luminescent" lamp devised by Ebert, the light appears to be accompanied by the smallest possible quantity of heat. The increase of efficiency due to this circumstance appears to exceed even what Langley's experiments would have led us to expect. A serviceable "luminescent" light was obtained with *one-millionth part of a watt*. The cost of the light compared with that of the amyl acetate standard lamp was estimated to be at least 1,500 to 2,000 times less. If we take the cost of lighting by the "luminescent" lamp as being only one-thousandth part of the cost of lighting by the incandescent lamp, there will still be a large margin to cover some of the drawbacks which no doubt would be entailed by the use of the former system. These estimates of efficiency are, however, professedly rough, and no doubt will soon be followed by more exact determinations. One of the objections to the use of the high frequency current is the practical impossibility of transmitting it through long conductors. This would necessitate a high frequency transformer being in each house, and the first requisite to further advance in this direction is the invention of such an apparatus for converting continuous or alternating current of ordinary frequency into high frequency. This transformer, however, could be so small, that one might be easily connected to each lamp if desirable. Tesla has shown that these currents are not dangerous, and the absence of heat would enhance the advantages which the present system of electric lighting already possesses over gas and oil.

Displacement Currents.

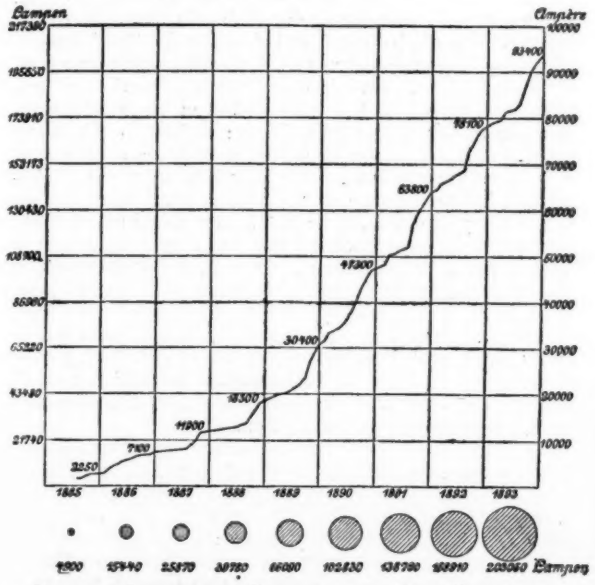
M. NICOLAIEFF has described before the Academie des Sciences a new method of measuring displacement currents in dielectrics. He suspends discs or rings of the substance by a bifilar suspension at 45° to the axis of a magnetic field, which may be made constant or alternating at will. The period of vibration of such a disc will be altered in a permanent field by the couples due to induced magnetism in the discs, and in an alternating field, by additional couples due to the displacement currents which are in phase with the field alternations. From the natural period, and those under the influence of the two fields, he is enabled to calculate the effect of the induced displacement currents. He has succeeded in measuring the effects in certain dielectrics, and also in some electrolytes; and he finds that the latter conduct themselves exactly like the former. A second method of experiment is described which gives similar results.

THE BERLIN ELECTRICAL WORKS.

We extract the following facts from a reprint of the *Commemorative Bulletin* of the 35th Congress of the Association of German Engineers, 1894 :—

The German Edison Company was founded in 1883 with a share capital of 5,000,000 marks, and in 1887 it gave rise to the Allgemeine Elektricitäts Gesellschaft. This company regarded it as one of its tasks to create undertakings which should supply every person with electric light from a central station, like gas.

To this end the company entered into negotiations with the municipality of Berlin, in virtue of which the company acquired the right to utilise the public streets of the city for laying down leads. The agreement of 1884 contained the following essential determinations :—The company is entitled to lay down its leads in the streets, but has no exclusive privilege.



Diagrams Showing the Growth of the Lamp Connection.

In return, the company pays the city 10 per cent. of the gross income, and, further, one-fourth of the net returns exceeding 6 per cent. of the capital expended, or a 6 per cent. dividend. Further, the municipality obtain certain privileges as regards the supply of light. There are also stipulations in case of the city taking over the works. On October 1st, 1915, the city can take over the installation at a valuation. In 1885 the works for supplying Berlin with electric light were constituted an independent company, with a capital of 3,000,000 marks, under the style of the Berlin Electrical Works. The present installation, with leads of the total length of 162 kilometres, is in a position to supply simultaneously 150,000 lamps at 16 normal candles each. There are five central stations, situate respectively in the Markgrafen, Mauer, and Spandauer Streets, in the Schiffbaurdamm, and in the Königin Augusta Street.

It has become necessary to adopt the three-wire system in place of the original two-wire system. The leads of the various stations form one connected net. They consist of asphalted lead cables, armed with iron bands, on the Siemens and Halske system. The cables ramify beneath the footways by means of cast-iron cases.

During the time of the heaviest consumption all the stations work in parallel ; but at all other times there are at the various stations convenient compensating arrangements in order to adapt the load of the net to the most economical work of the steam engines. When the demand is small, in the day, and the late hours of the night, one station undertakes the whole of the work.

The steam engines employed have the collective H.P. of 15,370. The series introduction of the arc lamps has given place to a parallel arrangement.

The use of current by different classes of consumers is as follows :—

Theatres	8·2
Banks	17·6
Shops	31
Beer-houses	9·4
Hotels	4·3
Industrial establishments ...	6·3
Dwelling houses	17·2
Street lighting	1·4
Various	3·8

The number of electric motors has increased in the period 1889 to 1894 from 17 to 360, with a consumption of more than 1,300 H.P.

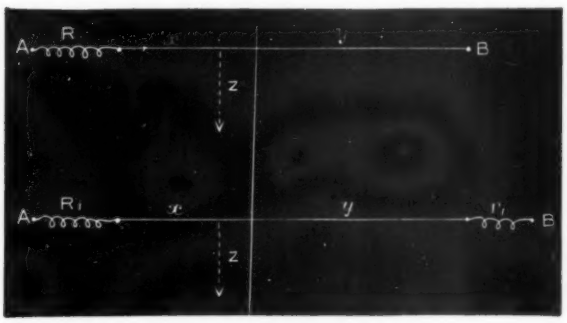
In the installations of the Berlin electric works for the average of the year, there were obtained from 1 kilo. of coal 560 watts of current, a result which has not been hitherto reached by any central station in the world.

MODIFICATION OF ANDERSON AND KENNELLY'S METHOD OF LOCALISING A FAULT BY THE "EARTH OVERLAP TEST."

By A. Jordan and W. Schönau.

In the *Electrician*, dated July 17th, 1885, Messrs. J. Anderson and A. Kennelly published a method for localising a fault by tests from both ends of the cable.

In this method (the earth overlap test) a variable resistance, R, is inserted at the end nearest the fault, fig. 1, and R



Figs. 1 and 2.

is varied until the resistances measured from both stations are the same.

This test has been of very great use, but it has a few drawbacks ; for instance, it takes, generally, a long time before any definite result can be arrived at, and the necessity of speaking between each set of readings tends to polarise the fault.

We propose to remedy these defects by balancing to a certain resistance, P, agreed on previous to the test, by using variable resistances, R_1, r_1, at *both ends* of the cable, fig. 2. A and B then earth alternately for each other, say, four or five times, A balancing to P ohms by varying r_1, and B balancing to the same resistance (P) by varying r_1 ; the test can in this way be taken, we believe, much quicker and without any need of speaking between each set of readings.

When the test is finished, the stations communicate the result to each other, and if it then be found that R_1 and r_1 have been unaltered in two consecutive sets of readings, we may consider the figures of one of these sets as being correct and can calculate the distance of the fault from them, it being easily seen that this distance from A is :

$$x = \frac{L + r_1 - R_1}{2}, \text{ where } L = x + y.$$

In order not to balance to a resistance higher than necessary, we will enquire which value it will be most advisable to commence balancing to.

We have when balance is obtained :

From A $$P = R_1 + x + \frac{z\,(y + r_1)}{z + y + r_1}. \qquad (1)$$

From B $$P = r_1 + y + \frac{z\,(R_1 + x)}{z + R_1 + x}. \qquad (2)$$

From which $$P = r_1 + y + \frac{z\,(y + r_1)}{z + y + r_1}, \qquad (3)$$

where y is supposed to represent the piece of cable from the fault to the end farthest from it.

Now, of course, it is important to have r_1 as small as possible, but, at the same time, we must have some resistance in order to compensate for variation in the fault ; when we, therefore, in (3) make $r_1 = 0$ we find that :

$$P \text{ must be greater than } y + \frac{y\,z}{y + z}. \qquad (4)$$

If we in (4) make $z = \infty$, we get the highest value which it in any circumstances will be necessary to give to P, namely

$$P = y + \frac{y}{1 + \frac{y}{\infty}} = 2\,y. \qquad (5)$$

And here again the highest possible value y can attain is $y = L$, that is, the whole resistance of the cable.

We therefore find that P must be *lower* than 2 L, but *higher* than

$$y + \frac{y\,z}{y + z}.$$

And here one of the values that most commends itself is

$$y + \frac{y\,z}{y + z} + x + \frac{x\,z}{x + z},$$

this being the sum of the resistances measured from A and B, the distant end being to earth, and consequently easily ascertained.

Should it be found, when the test is finished, that r_1 is unreasonably high, it can easily be calculated by what amount P must be reduced in order to make r_1 as small as advisable, and the test repeated.

The *modus operandi* of the test will then be as follows :—

A takes a test, B having put to earth, and obtains a ohms ; then A puts to earth for B, who obtains b ohms, then they communicate with each other and agree to balance to $a + b$ ohms (P) and to put to earth (through the variable resistance) for each other, say, five times, B inserting a ohms as first approximate variable resistance.

Then A takes a reading (*testing to false zero*) and finds that he must insert R_1 ohms in order to balance to P ; he then puts to earth for B through R_1 ohms, when B finds that he must alter a to r_1, in order to balance to P, he then puts to earth for A again, &c. When both of them, in this way, have obtained five readings, they compare the figures, and if it then be found that, for instance, R_3 is the same as R_4, and r_2 the same as r_3, these figures may be taken as correct ; otherwise the test must be repeated until two similar sets of readings are arrived at.

Above we have only applied the modification of the test to the "earth overlap" ; it can, of course, be applied with equal advantage to the "insulation overlap test."

THE EDISON FEEDER AND MAIN PATENT.

This patent, which has long been under litigation in America, has at last, in the higher Court, been declared void, the judgment being that it contained nothing patentable. What a commentary on the boasted perfection of the examination system of the American Patent Office ! It seems that with all the expert examiners, interferences, references, and the other elaborate machinery necessary to carry on this patent office, that a patent can be obtained without an invention.

An able writer on patent laws recently remarked on this question of examination of applications : "As to the *supposed* security of patents which have been granted under the examination system, it is sufficient to state the fact that as large, if not indeed a larger proportion of patents granted in the United States are declared invalid in courts of law, than is the case with patents granted in this country." This last case of the feeder and main patent is a striking instance for the particular consideration of those who have been clamouring for a system of examination in this country. It clearly points to the futility of examination, and proves what we have always held that it is—vexatious, expensive, and useless.

This particular patent was one of a batch of patents granted in the early days of electrical engineering, at a time when the patent offices of the world were being flooded by applications for patents for inventions of all kinds relating to electricity. The Edison party were particularly active then in filing specifications on every conceivable point in the business. The subject dealt with in the patent in question was the drop in pressure in the mains distributing electrical energy. The invention claimed was the combination of feeders, or what we now call transmission mains with the distributing or service mains for the purpose of maintaining the pressure at distant points.

This combination has been held to be no invention ; first, because it was known long before Edison's time that a drop in pressure would be found, and also how, by Ohm's laws, it could be accurately calculated, it was also well known how, by the same laws, we might calculate the proportions of conductors required for the transmission of electrical energy, allowing for any predetermined drop ; in fact, the feeder and main system was a simple arrangement in accordance with Ohm's well-known laws, and one which any practical electrician, before the date of the patent, would have devised without any invention, if he had been required to lay down conductors to carry electrical currents from a generator to various points at a distance. In fact, every electro-plater was practising the feeder and main system—on a small scale, it is true—but scale goes for nothing in a case of this kind. The electro-plater had feeders running out to each vat, or bath, and in each bath he had a system of distributing wires distributing the current in its proper proportion to each article in the bath, all in accordance with the then well known laws of current distribution.

This case raises some very interesting questions on electrical patents, for this is not the only patent in existence which has been issued for the mere application of well known physical laws. The test applied to this feeder and main case amounts practically to this : Could this combination be arrived at simply by calculations made according to well known laws ? If the answer is that it could, then there is no invention. No investigation, no experiments, were required to solve the problem ; it was done simply by the use of Ohm's laws. No new discovery was made. Now if we apply this test to the three-wire patent, how would it stand ? It also is one of those inventions, if it can be so called, arrived at by the use of common calculations according to well known laws. There is no new discovery in it ; it required no experiment, except with figures, to ascertain the working conditions. On these grounds the patent might also be contested. Another case is the trolley wire system ; any schoolboy might see that a current could be collected by scraping a contact along a live wire. As a system there can be no valid patent in that. Of course, there may be and is plenty of room for patents to cover inventions in details in a trolley system.

But no investigation, no experiments, no new discovery required to be made to devise a trolley system, it could all be calculated out by common laws, and is an arrangement any workman would have put up if asked to make a connection with a moving car and a live wire.

It will be seen that these patents, although containing little or no invention, being merely the results of common knowledge and ordinary arithmetic, are nevertheless very far reaching, and if allowed to be held, they practically control a vast business.

This decision in the feeder and main case luckily touches this class of patents on their weakest spot, and will tend to put a stop to the control exercised by such patents over important industries.

The invention of a telephone, a phonograph, an alternating motor or transformer, a new dynamo, a new arc lamp, or a method of making carbon filaments, required inventive ability, patient study, investigation, and expensive experiment, before practical success was attained, hence the original patents were for genuine inventions ; but these

patents only control the special appliance or thing invented, while the patent for the spurious invention, consisting of the obvious application of well-known laws and results of formulæ, control whole industries, for the claims in such patents practically amount to claims for fundamental natural principles, so disguised that they pass the Patent Office unnoticed. The time has come, however, when these so-called "controlling patents" must be scrutinised closely before accepting them as covering genuine inventions.

Another feature of these controlling patents to be noted is that they never have come in to fill a long felt want. In many cases of genuine invention it is often said in opposition thereto that it was an obvious thing to anyone; but the reply to that is generally, that although hundreds of people had been engaged on the subject of the patent for years, no one had thought of the *obvious* improvement except the inventor. That reply, however, cannot be made in the case of these controlling patents, for they have invariably been taken out *before* they were wanted. They were not known as "felt wants," so that it is quite legitimate in these cases to assert that the combination and the results secured by it were obvious, and known to many electricians other than the patentee; in fact, that others did not see any patentable matter in them at that time or ever afterwards.

of similar size, and forms part of the area enclosed by the common roof.

It occupies a corresponding part of the area on the other side of the entrance stairway, is built of brick, and has a glass roof supported so as to leave a space of 2 inches between it and the top of the walls. The floor, which has a slight fall from the sides towards a drainage trap in the centre, is formed in concrete about 12 inches deep, being finished off with a top layer of insulating composition. It is found, as one would expect from the prevalence of acid vapour, that the insulating value of such a facing is but slight; leakage shocks of small amount are felt, indicating the presence of leakage generally, but not of a serious character. A cable trench runs from the battery room to a point inside the laboratory. This conduit is lined with glazed brickwork, bedded in concrete, with a sump at lower level to catch infiltrated water. The trench is covered with scarple-jointed slates where under cover, but outside protection is given by Caithness flags laid watertight. In the area an iron cable tank is also placed. This is 6 feet in diameter by 4 feet deep, and is used for water tests of cables, the insulated ends of which are carried clear of the water by an insulator on an iron bracket fixed to the end wall of the battery room. The other end of the cable under test is taken along

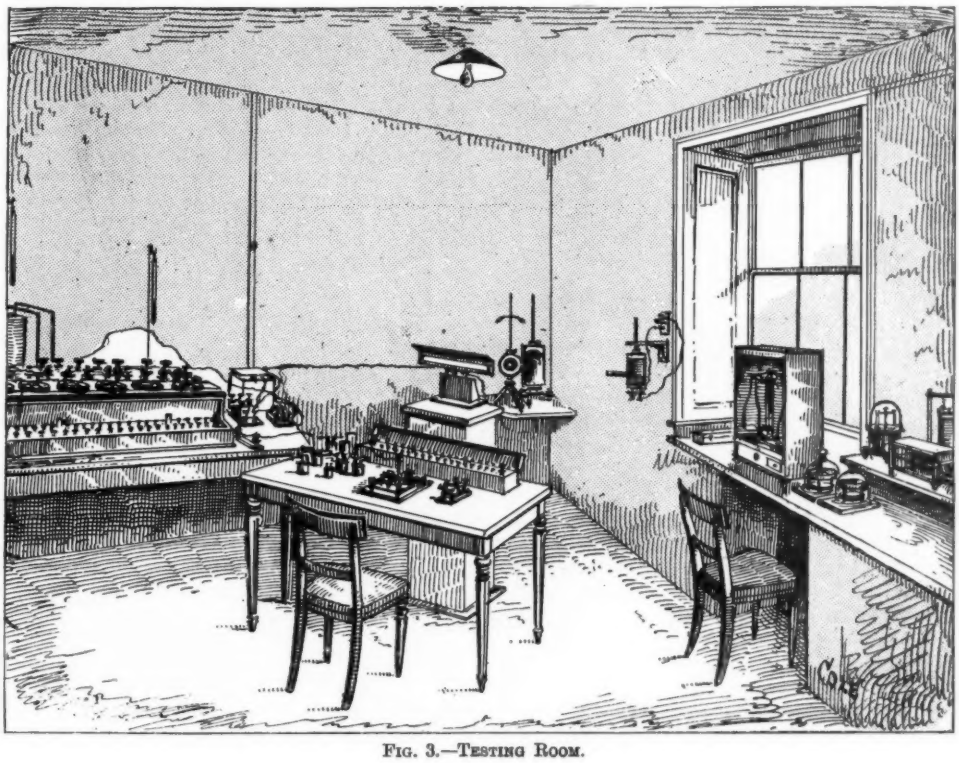


Fig. 3.—Testing Room.

STANDARD UNITS FOR ELECTRICAL MEASUREMENT.

(*Continued from page* 400.)

III.

Engine and Battery Rooms and Cable Tank (*continued*).

The charging dynamos are a couple of Kapp machines, made by Messrs. Johnson & Phillips, and fitted with heavy fly-wheels. They are mounted on slide rails. One of the machines has an output of 38 ampères at 138 volts when running at 1,100 revolutions per minute, this pressure enabling it to be used for charging a battery of 108 E.P.S. 11 L cells, 1888 type, coupled in two parallels of 54 cells each. The cells are mounted on the usual heavy wood frames, and are independently insulated by the customary oil insulators. The battery room is next to the engine room, the main building for some distance about 10 feet above the ground level, and is led into the laboratory by a glazed pipe through the wall, coming in at the high pressure corner.

The second of the two dynamos gives, at 950 revolutions, 200 ampères at 12½ volts, and is used to charge four large Crompton-Howell cells in series. These cells have been procured for the purpose of giving a discharge of 1,000 ampères when coupled in series, but they have also been arranged to be coupled in two parallels of two in series, and by this means currents up to 2,500 ampères are available for laboratory purposes. Each cell consists of 61 plates carried by insulators in a lead-lined containing box 4 feet 6 inches long by 12 inches square. The positives are lead-burned to a lead bar of 1½ square inch section extending the length of the cell, while the negatives are joined to a similar bar on the other side; the cell bus bars are borne by insulators carried by upright iron bearers rising from the wooden frame on which the cells rest. The junctions between the first and second, and third and fourth cells, are made by autogenous

soldering of corresponding positives and negatives to a common bar between these cells. For outgoing leads soldered connections are made to lead pillars rising from the centre of each of the outer cell bus bars.

The charging switchboard in the engine-room is provided with instruments giving an approximation to the value of the charging currents in each circuit; these are protected by automatic switches, fuses, and, for control, a brake switch is inserted in each. The automatic switch on the 200-ampère circuit makes and breaks; that on the 38-ampère circuit formerly only broke, but is now arranged to both make and break. The charging mains to the Crompton-Howell cells consist of triple cables of 19/16 Silvertown insulated cable, soldered to the cell bars by means of copper strips connecting the lead pillars before mentioned. The mains for the E.P.S. cells are arranged so as to produce no appreciable external magnetic field, and are brought to a switchboard by which the double switches can couple one or other or both batteries in parallel. They can be used to supply current to the motor in the machine room, or to the low pressure mains in the laboratory. They are largely used to give voltage currents for wattmeters, while the Crompton-Howell cells supply the current for the ampère coils. Safety fuses are fitted to all circuits throughout the laboratory whether on high or low pressure.

Testing Room.

In this room, which is shown by the view given in fig. 3, are placed the chemical and general weighing balances. This room is rather smaller than would be convenient for general electrical work, so it is given up to resistance measurements which do not require leads from external sources. It is also used as a storeroom for the finer class of apparatus not in general use. As resistance measurements are pushed to the utmost limit of accuracy, temperature variations become of first importance, and the temperature of this apartment is kept perfectly uniform by means of a thermostat controlling a gas-heater. Mirror galvanometers, a large dial bridge, Carey-Foster bridge, and several ohm coils of home and foreign manufacture find their place in this room. It is at once one of the least pretentious, but one of the most interesting and important departments of the Electrical Standards' Office. Quiet, and absence from vibration to any marked degree, render it a position well suited to its purpose.

Machine Room.

The machine room serves a double purpose. At one end it is arranged as a workshop, and is fitted with a foot-turning lathe and two benches. A very complete set of tools, both for wood and iron, have been provided, and the fireplace has been fitted so that it may, when necessary, be used as a small furnace. This room, as can be imagined, has been of great service. The advantages of being able to repair or to construct experimental instruments on the spot and without delay while the work is under the supervision of the officials, cannot be over estimated. The assistant in the laboratory is a highly capable and expert mechanician, and is, therefore, able to make the most of the facilities offered.

The other end of the machine room, of which we give a view in our illustration, fig. 4, has a concrete floor extending to a depth of 18 inches, and on this floor are laid the foundations of the machines; the upper surfaces of the beds being raised 6 inches above the general level, with a total depth of 3 feet 6 inches. A trench formed in concrete, and lined with an insulating compound, serves as a receptacle for the various cables and leads passing between the machine room and the laboratory switchboard. Where these may be used, however, for currents at high pressure they are enclosed as far as possible in bitumen pipes laid along the roof. This precaution, as will be noted later, was adopted when tests began to be made up to 10,000 volts alternating, when the limit was 2,500 volts well insulated conductors gave the necessary safety. The leads used for the higher pressure are heavily insulated and stand 10,000 volts perfectly.

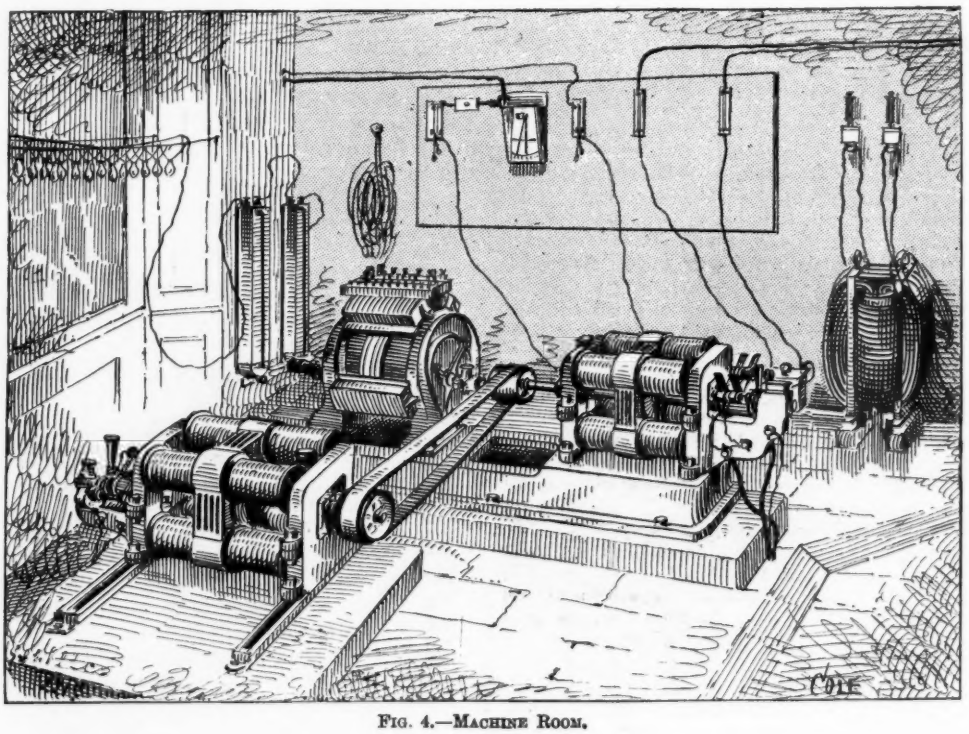


Fig. 4.—Machine Room.

The machine room plant consists of a B_2 Victoria dynamo, used as a motor to drive a special Mordey alternator, and also a C_2 Victoria dynamo. The latter is arranged to give continuous pressures up to 2,000 volts. The alternator is in line with, and coupled direct to, the armature shaft of the motor, as shown in fig. 4. The dynamo for high pressure continuous currents is driven from the motor by a short belt, but if this should at any future time prove unsuitable, friction gear would be substituted for it. For alternating pressures there are two Mordey transformers of two units

each, by which the alternating pressure can be run up to 2,500 volts. For alternating currents a Mordey step-down transformer is used, which is capable of giving currents up to 500 amperes, or even more if power be available. The transformers are provided with terminals arranged to give various multiples and sub-multiples of transformation should such be desired. The method of regulation and control will be considered when we come to the testing arrangements. Additional transformers have been arranged for 1,000, 2,000 and 10,000 volts alternating. If large powers are required, the transformer house in which plant is installed, taking supply from the street mains of the London Electric Supply Corporation, enables the demands of the laboratory to be met. This chamber is situated at the southern end of the area, in a line with the engine and dynamo rooms, and is connected with the laboratory and machine room by leads carried in bitumen pipes running along outside the building, and visible from the street. There is nothing peculiar to the laboratory in the arrangements by which current is taken from this outside source of supply.

(To be continued.)

CORRESPONDENCE.

Aeronautics.

Some years ago I commenced a series of experiments at Baldwyn's Park with a view of ascertaining whether or not it would be possible to make a machine sufficiently light and powerful to raise itself in the air.

Many experimenters before my time had attempted the same thing, but I believed that I should be able to make a stronger engine and a lighter machine than had heretofore been made. After a great deal of study and investigation, it appeared to me that the steam engine would be the most suitable for the purpose. It also appeared to me that the screw propeller would be the most suitable for driving the machine forward, because I found that it not only got a good grip on the air, but that a very large amount of power could be applied continuously in this way. For lifting, I believed the aeroplane, or a system of aeroplanes, would be the most effective. The lifting effect of the aeroplane, as is well known, is produced by driving it at a high velocity through the air. In order to be able to do this, I provided myself with a railway track. As my machine became more and more improved, it was found necessary to provide a second track above the wheels, so as to prevent the machine from leaving the track before the art of flying had been thoroughly studied and the machine properly balanced. When everything had been brought to a high degree of perfection, it was found that if the engines were run to nearly their full power, the machine could be lifted quite off the lower track so as to run along the upper track, showing that the machine not only could carry its own weight, but, in addition to this, whatever pressure happened to be on the top rail.

On the last occasion, the engines being run at a very high velocity, the lift on the top rail became sufficiently great to bend the axletree on one side, and lift up the track on the other side. The broken track passing through the lower framework of the machine broke some of the tubing without injuring any of the machinery or the aeroplanes. The experiments, as I said before, were for the purpose of ascertaining if a machine could be lifted by its own energy. The total lifting effect at the time of breakage was 10,000 lbs.

These experiments have been tried with great care and in a thoroughly scientific manner, and for a scientific journal like the Electrical Review to speak of these successful experiments as "abortive," is not what one would reasonably expect.

In regard to the employment of electricity as you suggest, I think it would be well enough to consider this question of electricity when some one has demonstrated that they can produce a motor which is as light as my steam engine. I went thoroughly into this question, and ascertained that any form of electrical motor was quite out of the question, on account of its enormous weight. You suggest generating the electricity on the ground, and taking it to the machine through "cables capable of being rapidly paid out." Two wires would be necessary, and if the machine went at the rate of 40 milts an hour, a few seconds would suffice to have a large amount of cable in the air; moreover, a machine which is attached to the earth by a cable cannot be considered a flying machine.

However, if the Electrical Review prefers to use electricity, may I suggest that they should construct a machine which will lift its own full weight—including the whole of its motor and 2,000 lbs. besides—as I have done? When you have done this successfully, I, for one, will not call your experiments "abortive operations."

Hiram S. Maxim.

The Electric Motor and Some of its Applications.

In your issue of last week an article headed "The Electric Motor and Some of its Applications" contains the following paragraph:—

"An instance of a small transmission scheme, some 20 horse-power or so, was carried out by Messrs. Laurence, Scott and Co., at the Anglo-Bavarian Brewery, Shepton-Mallet. In this case the motors are employed for pumping water three-quarters of a mile from the brewery."

The above plant is of 30 actual horse-power, but is not yet run up to its full power, and although the dynamo and motor were made by Messrs. Laurence, Scott & Co., they were made to our order. The whole installation was designed, contracted for, and erected by us.

Wynne & Barnard.

October 9th, 1894.

Vacuum Tubes.

I should be much obliged if you would tell me if vacuum tubes will glow when connected to only one terminal of an induction coil.

A. Raymond.

October 4th, 1894.

[Yes, if special high frequency currents are used, as in Tesla's experiments; but not, we think, with an ordinary induction coil employed in the usual way, although if the free end of the tube be brought very near to the unused terminal, it might possibly glow.—Eds. Elec. Rev.]

The Volt.

Will you kindly tell me how many electrostatic units of potential there are in one volt, also, if on an ordinary high-tension voltmeter the reading is correct for measuring potential from a static influence machine?

Thanking you in advance for kind reply.

Puzzled.

[A volt is one volt, whether produced by friction or induction in an influence machine, or by a dynamo or battery, and Lord Kelvin's, or any other electrostatic high-pressure voltmeter will measure, quite correctly, the P.D. in volts at the terminals of an influence machine.—Eds. Elec. Rev.]

The Halifax-Bermudas Cable.—At the recent meeting of the Halifax and Bermudas Cable Company, the chairman stated that the cable had remained in perfect condition from the time it was laid until the present time. This is no doubt a very interesting fact, considering the evil prophesies concerning the cable which were so frequently made at the time it was resolved to go on with what was considered to be so difficult an undertaking. The cable was laid in July, 1890, and its immunity from disaster of any kind is no doubt due largely to the careful soundings which were taken, and the knowledge thus obtained of the bottom on which it is laid. Those who were interested in the undertaking were not satisfied to trust *entirely* to the apparatus employed for the laying, as a certain eminent electrician has stated his willingness to do in respect to the proposed Pacific cable.

NOTES.

Incandescent Gas Burners.—Within the last few months a considerable development has taken place in the application of gas burners surrounded by a hood of some refractory substance, which becomes incandescent when the gas is lighted. This is not the first occasion on which it has been attempted to introduce burners on this principle, the previous attempt having failed because of the rapid deterioration of the hood. Whether the present revival will meet with more success we do not know, but think that the short life of the hoods will be found a considerable bar to their success. We, however, have hitherto wished success to this as to all efforts to improve the character of gas lighting, and we would welcome any means which would enable us to get a better light from our gas or to get the same light by a smaller consumption of gas. Although we want light in our houses, we do not want the products of the combustion of gas, and the less we can have of this the better. Of course, we are referring to places where electric light is not available, or is not likely to become available for a considerable time. But according to an extract, which we give elsewhere, from a continental paper, it appears that hopes on this matter are doomed to disappointment, for it has been shown by apparently convincing experiments that one burner of this type—and they are all alike—produces an amount of carbonic mon-oxide gas which is quite poisonous. The text-books of chemistry tell us that even 1 part in 10,000 of air is a poisonous proportion, but the authority we quote finds 1 in 4,500 in the atmosphere of an ordinary room lighted by these burners. We think this circumstance should be noted by all persons interested, and that they should not hastily make any changes in the arrangements of their gas burners under the impression that they will obtain an improved result in the healthiness of their homes. We would also call the attention of persons interested in public buildings to this matter, as it is one that affects them closely. Let them rather endure—for a little while longer—the ills they have.

In the full page advertisement of this burner in the *Times*, there are some figures which invite attention. On the subject of exactly what the gain in consumption is, the statements are exceedingly contradictory. They vary from a saving of one-third in the gas bill to an increase in light of 870 per cent. Let us take a few examples. In one place referring to private houses, and we suppose to a comparison with the ordinary burners that most people use, it is claimed that their burner "reduces the gas bill by *one-half*." But in several other places they state that an ordinary open flame burner takes 7 cubic feet and gives 14 C.P., while the incandescent gas burner takes 3½ cubic feet and gives 60 C.P. That is to say, 7 cubic feet gives 120 C.P., as against 7 cubic feet giving 14 C.P. This is an increase not of 1 to 2, but of 1 to 8·7! Which of these figures are we to accept? This vagueness is a characteristic, too, of their witnesses. Mr. George Livesey is quoted in oft-repeated capitals, and says that the effect of the burners is to reduce the price to "half or even a quarter." Surely Mr. Livesey ought to emit some more certain sound than this, and he might also base his comparison on something more than the mere quantity of gas used. He (no doubt wisely) refrains from including in his estimate any figures as to the first cost and the depreciation of these new burners in comparing them with the ordinary article. Another writer quoted asserts that the reduction of his gas was from 64,000 to 44,000. We wonder this person was deemed worthy of a place with a meagre reduction of one-third, especially as, again, nothing is included for first cost or maintenance. The note of vagueness, however, reaches its highest when "Prof. Max Müller has much pleasure in stating that . . . . . his gas bill last quarter was £1 2s. less than the same quarter last year!" The learned and ennobled professor, we all know, occupies no chair of mathematics or even of arithmetic, but he might have gratified our curiosity by telling us whether the reduction was 1 per or 100 per cent.! We may be sure that the comparison of that poor old-fashioned illuminant, electric light, with this new gas light, is very unfavourable to the former, for it is shown "by figures" that electric light is eight times the cost of gas. But the writer of the advertisement has a short memory, for only a few lines further down it becomes ten times the cost of gas! Whether this is on the basis of one-third saving or of 1 to 8·7 increase, we are not told! We will not waste time by further analysis, but must express our belief that the qualities shown by the writer of this enormous advertisement are admirably suited to the composition of a flaming company prospectus, for which noble task we regard the present publication as a very excellent preparation.

Popular Science.—One of the effects of technical education is to unbalance the minds of those receiving instruction, unless they are prepared to be thorough, and master one subject at a time. An evidence of the failing that leads to teaching before even an elementary grasp of the subject has been obtained is shown by some remarks in the leader of *Industries and Iron* last issue. After muddling through some heat unit definitions, in which thermometer scales, equivalents, and work units were mixed up promiscuously, the writer says that:—"In electricity the dynamic factor of *time* must be introduced, and we get the well-known units founded on the centimetre-gramme-second or C.G.S. unit of the British Association." What a beautiful confusion of ideas, or want of any! It is easy to see that units have not yet been understood by the writer, as later on he confounds work and power, energy and duty, convection and conduction, and sundry other things, such as the mechanical equivalent of heat for Centigrade and for Fahrenheit scales. It is a common error to find energy and work confused, but there is no excuse in the case of work and power, and we should advise the tyro to carefully read an elementary text-book on "Heat" before penning effusions upon subjects of which he is grossly ignorant.

The Progress of Telegraphy.—The statistical abstract lately issued by the Board of Trade gives information regarding the growth of telegraphic communication in the principal European countries and in the United States during the last 25 years. It appears from the data given that Germany was the first country in which a telegraph line was opened, in 1833. It is well known that in this country the first successful essay of a practical electric telegraph was made on July 25th, 1837, by Cooke and Wheatstone, between Euston and Camden, on the London and North-Western Railway, and that the first telegraph line was set up in 1838 on the Great Western Railway, from Paddington to West Drayton. The United States followed in 1844, and then came in order of introduction Belgium, Austria, Italy, France, Holland, Switzerland, Sweden, Denmark, Norway and Spain, in the last of which countries the first line was opened only on May 1st, 1885. No data are given for Russia, and the statistics for that country come to end with 1880, Russia being then fifth in the list of countries as regards the number of messages carried. The smallest number of messages despatched in 1870, the first year selected, was 466,700, in Norway, and the largest number, 9,350,000, in Great Britain. Germany was third in the list, with 8,207,800 messages. The United States had a slightly smaller number of messages to its credit than Great Britain, the total being 9,157,646. In 1892, after the lapse of 22 years, Norway had still the smallest number of messages carried, viz., 1,649,544. Germany seems to have dropped from third place to fourth, with a total of 31,175,100. No figures are given for France in 1892, but in 1891 the number of messages carried was 32,397,000. The United Kingdon still retains the first place, its total in 1892 being 69,908,600, compared with 62,387,298 in the United States. Austria held fifth place in that year with 10,835,302, and Italy seventh with 8,322,925. Regarding the proportion between the number of messages carried and the population as a whole, it appears that in 1870 Russia showed the smallest proportion of messages carried per head, only 0·04 per head of population. Of the five countries which held the next lowest rank to Russia as regards the proportion of telegrams to population, viz., France, Italy, Sweden, Spain and Hungary, the first-named has since made the greatest strides, and is now amongst the first five countries compared in this respect, increasing from 0·1 to 0·9. Switzerland, in 1870, was first among the countries, with 0·6 messages per head. In the interval its proportion has been doubled, but it now holds only second place, the United Kingdom being first with 1·8 message per head. The United States, with Holland and Belgium, falls into third place, having 0·9 message per head.

Fatal Accident.—A double fatality through electricity occurred in Boston, Massachusetts, on 4th inst. While a man was employed cleaning an electric light on the top of a high pole he received a shock of the full strength of the current and was killed instantaneously. His body was suspended from the wires for half an hour. When men were put to work to remove it, one of them came in contact with it, and was thrown head foremost on the sidewalk. He was dashed with such violence against the kerbstone that he died shortly afterwards.

Continuous Current Dynamos.—*Science Progress* for this month contains an article on continuous current dynamos. It treats the subject so far historically, and is mainly a repetition of the oft told tale of the parts played by the Drs. J. and E. Hopkinson in dynamo progress. The writer ignores Kapp's prior work in teaching the properties of the magnetic circuit, and giving engineers a formula in inches, feet, and Kapp lines, of vast importance to practical men. Of the methods for neutralising the effect of cross turns, the writer gives that one in which the air gap is widened for the purpose; he has evidently forgotten Bayer's method, which is more scientific, and infinitely better. We are not aware that the initial cost of iron-clad dynamos is greater than others, as is hinted by the writer; we know some iron-clad dynamos which are said to be the cheapest in the market. The article might very well have been entitled "Hopkinson's Continuous Current Dynamos, Part I." We hope to find something more interesting in Part II.

Street Railway Convention at Atalanta.—At Atalanta, from October 17th—20th, is to be held a convention of members of the American Street Railway Association. The following is a copy of the programme:—Reports of special committees on the following subjects: "A Standard Form for Street Railway Accounts;" "Can the T Rail be Satisfactorily Used in Paved Streets?" "City and Suburban Electric Railways;" "Mail, Express and Freight Service on Street Railway Cars;" "Standards for Electric Street Railways;" "Street Car Wheels and Axles;" "The Best Method of Treating Accidents and Complaints;" "The T Rail Construction of the Terre Haute Street Railway Company;" and "Transfers and Commutation." Notice has been received by the secretary that special papers will be read on the following subjects: "A Practical System of Long-Distance Electric Railway Work;" "Brake Shoes," and "Destructive Arcing of 500-Volt Fuses."

Incandescent Gas Burners.—The following paragraph, to which we refer on another page, was recently published in the Frankfort *Zeitung*: "The weighty question—what influence the consumption of lighting gas exerts on the health in inhabited rooms—has lately been looked into by the French physiologist, Gréhant. This investigation gives us most noteworthy results in relation to the now so extensively used Auer light. Gréhant gathered in a holder of 150 litres capacity the products of combustion of ordinary lighting gas after using burners of the old system, and then the Auer burner. The analysis gave in the first case the smallest trace of carbonic oxide gas, but in the case of the Auer burner, carbonic oxide gas was found in considerable quantity, the exact proportion being 1 : 4,500, and this was accompanied by almost an equal quantity of fire-damp gas. The existence of carbonic oxide in the combustion products of gas consumed by Auer burners was demonstrated in several ways—chemically, by its well known reaction on copper salts; physiologically, by proving its existence in the blood of animals which had breathed the consumption products for some moments. The French Journal, from which we take our information, concludes as follows: 'If we wish to take care of our health, we must banish the Auer burner from our dwelling rooms. It is certainly very pretty to get a brilliant light in a cheap manner, but it is a hundred times more to our interest not to expose ourselves every evening to the poisoning effect of carbonic oxide gas.' It will interest us," adds the Frankfort *Zeitung*, "to learn how the Prussian Ministry will feel in the face of these results, seeing that last year by decree the Auer burner was recommended for use in schoolrooms." It is doubtless known to our readers that the Welsbach burners are being much used in places where new buildings are being fitted.

Breakdown in the City Supply.—Inconvenience was caused in the City on Tuesday afternoon during the foggy darkness by a stoppage in the supply of the City of London Electrical Lighting Company. Fortunately the stoppage was only of short duration, and was confined to the domestic lighting of a portion of the central district of the City. In reply to an enquiry from us, Mr. Bull says: "In answer to your telegram of to-day's date, I can assure you that no one can be more annoyed at the interruption of the light than we ourselves. It was caused through the failure of a temporary machine which had been erected by our contractors to enable us to cope with the very heavy demand required by our customers, pending the erection of further permanent plant. The latter is now almost ready to run, and only a few days ago it was decided to have the machine which broke down removed. Every precaution is being taken to prevent any repetition of the occurrence." We do not wish to criticise too keenly the unfortunate occurrence, but we must take it as a confession of weakness that the sudden stoppage of lighting should be due to the breaking down of a *temporary* machine. The City of London Company should by this have got beyond temporary devices.

Governing Electric Lighting Steam Engines.—Our contemporary, the *Engineer*, refers to some complaints about bad governing of steam engines, and it seems that the misbehaviour complained of is the sudden blink in the lights at the moment a large load is thrown on or off. There is at present no remedy for this, except the very practical one at the disposal of electrical engineers, and that is to prohibit the use of switches for putting on over a certain power. No governor can cope with a sudden increase of load over a certain percentage of the full load; the instantaneous change of load makes an engine stagger however perfectly governed. And, furthermore, even if the engines did not stagger, the dynamos would cause a blink on a sudden change in load of large value, for the field excitement cannot instantaneously change in a compound machine, nor can an attendant instantaneously change the excitement in a shunt or separately excited machine. The variations in load, although rapid at times, are generally made by small increments or small reductions. Unless electrical engineers can arrange their circuits so as to avoid the cutting in or out of immense loads with one turn of the wrist, we are afraid they must look in vain to mechanical governors to save them from the consequences of their injudicious methods of working.

A New Invention.—We have received the following communication, which we reproduce without alteration:—

Persia, Iowa, September 28th, 1894.

The Electrical Review,
London, England.

Gentlemen,—I find that the nations of East are actively Engaged in solving the Problum of marine Naigation. But they lack the motive power to complete their work.

I would say I have conceived a Plan that may be of great use in that respect. The motive fource is Entirely new, and we all know their is Power in Gun Cotton if it can be Properly Harnaced to do the work, although it is an untried thing yet I have confidence as a Practical mechanic to believe it would be a sucksess.

I am willing to do the thing in this way: If the Parties who may be Responsable are willing to sighn a contract to try the thing, and if it Proves a sucksess, I am to be Remunerated in a liberal way and if a failyer to receive nothing. Is that not fair? It would be Imposable for me to go the Journey to oversee the work, but I can send a model and specification of the mashine, but first and foremost there must be contract Properly made out.

It will be so arainged that aLey amount of Pistens can be used and so aminged that the Whole can be used or a part of them The whole thing would not weigh ovee 500 lb. and you know the Gun Cotton is not Bulkey nor heavey. I am not going to say it is a cheap Power to run, but in its construction it is not costley. I think I can dispose of the noxious gases as fast as created now if you want to try the Experiment you can do so. Purhaps you do not want to invest in an uncertainty, but if you do I will do all I can in my Preason health to forward it.

Yours truly,
P. Pelton.

Address
Persia, Harrison Co., Iowa, U.S.

University College, Liverpool.—On Wednesday evening Prof. Lodge commenced his course of lectures on "Electric Radiation and other Recent Advances in Electricity."

South Shields.—We hear from our friend who advertised in our issue of September 28th for tenders for making the 52 drawings required by the South Shields specification (boilers excepted), that on the basis of the lowest tender received the said drawings would cost the sum of £65 without designing. Our friend has come to the conclusion that this particular form of gambling has nothing to recommend it, so he has gone off to Monte Carlo with the object of getting a little amusement and relaxation out of his £65.

Durham College of Science.—At Newcastle-on-Tyne, on Tuesday last, the south-east and south-west wings of the Durham College of Science were inaugurated by the Mayor (Alderman Stephen Quin). The College of Science represents in Newcastle the faculties of science and engineering in the University of Durham, and its students obtain the science degrees and engineering diplomas of the parent University. In 1888 the extension of the Central Railway Station necessitated the removal of the college, and before that time arrived the authorities sought a permanent and more capacious habitation. They secured a splendid site at Barras Bridge, and plans were prepared providing for a magnificent quadrilateral range of buildings, the four wings enclosing a courtyard. The north-east wing was begun first, the foundation stone being laid by Lord Armstrong in 1887, and the buildings were inaugurated by Princess Louise (Marchioness of Lorne) on November 5th, 1888. This wing includes the chemical and physical lecture rooms and laboratories, museums, and preparation rooms, and in it the whole work of the college has since been carried on. As quickly as possible, the council proceeded to the erection of the wings at the south-west and south-east. These include the whole of the apartments to be devoted to the study of engineering and the fine arts, and the accommodation provided is ample and suitable. The finest of the rooms is the George Stephenson Engineering Laboratory, 123 feet long and 35 feet wide, supplemented by an annexe 9 feet wide for the greater part of its length. The portion of the college yet to be built is the main wing, which is to include the administrative, literature, and agriculture departments. A sum of about £90,000 is needed to complete the buildings and to relieve the council of their liabilities. The proceedings on Tuesday opened with a luncheon, the guests assembling in the Johnston Chemical Laboratory. In the evening a conversazione was held in the college. In the different sections of the buildings there was a variety of entertainments, exhibitions, demonstrations, &c. Prof. Garnett, late principal of the college, delivered an address in the art studio. Prof. Merivale has sent in his resignation of the office of Professor of Mining at the college. During the proceedings at the College of Science, it was announced that Sir Lowthian Bell had supplemented his many munificent gifts to the College of Science by a special donation that day of £1,000. Dr. Hodgkin, in the course of his remarks towards the close of the gathering, said he had not totalled up Sir Lowthian's previous gifts to the institution, but they had been on the most liberal scale, and represented a very large sum.

Telegraphs in the East.—At an ordinary time, says the *Pall Mall Gazette*, it would be a matter of no interest to the ordinary public to learn that there is every chance within the next few months of a connection being established between the telegraphic termini of Momein and Nampoung. Just now the news is of interest, for these places are the last stations before the gap between China and British Burma. They are separated by a mere 60 or 70 miles; the apparatus is all ready, and our engineers will, if they are allowed, "connect" in a very few weeks with the station so ably promoted and worked by Mr. Jansen, the Danish engineer in charge of the end of the Danish line. If it does nothing else, the new line will reduce the rates of wiring from India to the Far East by about one-half, or from five rupees to something between two and three. With the now full-blown Oriental complication suspended over us, and still far from solution, the new extension may be made still more practically useful.

BUSINESS NOTICES, &c.

Universal Electrical Directory (J. A. Berly's).—Messrs. H. Alabaster, Gatehouse & Co. have now in course of preparation the 1895 edition of this directory, which embraces all connected with the electrical trades throughout the Universe. It is indispensable to all having business transactions in the electrical world. Names and addresses for insertion, corrections, and orders for advertisements should be promptly forwarded.

Aberdeen.—Some new offices lately erected for the Great North of Scotland Railway are lighted throughout with electricity.

Alderley Edge.—The Local Board have decided to apply to the Board of Trade before December next for a provisional order with reference to electric lighting in their district.

Bayswater.—Some days ago the electric light, which has just been installed in the Bayswater Synagogue, was switched on. The existing candelabra on the reading-desk and in front of the Ark have been converted into electric candle lights. The galleries are illuminated by 10 four-light electroliers, and the gentlemen's seats by 8 of three lights each, giving a total of 100 lights of 16 candle-power, the scheme being very brilliant. The hall, staircase, vestry-room, and offices are also lighted by electricity. The whole work, which has been accomplished without closing the Synagogue, or in any way interfering with the services, has been carried out by Messrs. Bergtheil & Young, under the personal supervision of Mr. Arthur Bergtheil, M.I.E.E.

Belfast.—An assistant electrical engineer is being advertised for.

Some new extensive hospital buildings, to be erected here, are to be lighted by electricity.

Bournemouth.—At the last meeting of the Town Council upon the question of the electric lighting of the Winter Gardens coming up for discussion, a letter was read from the Electric Supply Company offering reduced terms. A letter was also read from Messrs. Roger Dawson, Limited. The Town Clerk was instructed to reply that the Council are not prepared to accept the terms proposed, but would be willing to enter into an agreement for 5½ years, as from September 29th, on being allowed a discount of 40 per cent. from the current price for the time being, instead of 15 per cent. as at present.

Bolton.—Wednesday, October 24th, has been fixed for the formal opening of the new electricity works in Spa Road, and the turning on of the electric lighting current from that station. Mr. Alderman J. Miles, J.P., chairman of the Gas, Electricity, and Street Lighting Committee of the Town Council, has consented to perform the opening ceremony.

Bray.—The Commissioners the other day resolved to promote a bill authorising them, among other powers, to "purchase, equip, and carry on electric light works."

Buenos Ayres.—It is stated by the *Financial News* correspondent that a big syndicate of British capitalists has been formed to start in Buenos Ayres large works for electric illumination of the city.

Burton.—Mr. Ramsden has been instructed to ascertain what amount of current would be required by residents in Ashby and Alexandra Roads if mains are laid there.

Cardiff.—The local papers have been making statements regarding the backward condition of the electric lighting installation, and complained that the engineer was waiting for the gun-metal tubing. We are given to understand, from an authoritative source, that things are, so far as concerns the contractors and the engineers' portion of the work, in a satisfactory condition, for the engineer (Mr. W. H. Massey) on Monday last, October 8th, steamed the two small (75 H.P.) and two large (300 H.P.) engines, and tried the condenser, &c. Further, Messrs. Siemens Bros. and Messrs. Ferranti are now trying their dynamos, rectifiers, and lamps at the station prior to hanging the lamps in the streets. It appears, however, that sufficient attention is not being given to the getting in of applications for supply of current, as it is stated that up to Monday last very few had been received.

Carlisle.—The Gas Committee have decided to make application for a provisional order.

Castleford.—The Local Board have placed the electric lighting question upon the shelf for the present, and have left the question to be dealt with by the new District Council when elected. Mr. Robert Hammond has been written to accordingly.

Cheltenham.—We understand that the light is being pushed very hard in the town by contractors, and the competition in wiring, &c., is likely to be very keen, eight local firms having taken up electric lighting, and several engineers from other towns are contemplating opening branches there.

Darlington.—At the Town Council meeting the other day the minutes of the Gas Committee included one referring to the provisional order the Council had obtained for the electric lighting of the town. In reference thereto, Alderman Walker said they would have to spend at least £30,000 in plant if they introduced the light, and they could count on their fingers the number of users of it. Councillor Barren said they had been in communication with the Local Government Board, whom they had assured that when there

was any demand for the electric light which seemed to warrant the outlay they would either supply it themselves or arrange for some company to do so under their control. He believed there was no danger of the provisional order being revoked.

Douglas (Isle of Man).—Enquiries are to be made as to the comparative costs of gas and electricity for lighting purposes here.

Complaints have been made lately that the new electric trams on the Douglas and Laxey line are causing obstructions, and the commissioners have been in communication with the company upon the subject.

Dover.—Some of the members of the Town Council do not like the position of certain of the electric lamp holders. In consequence, the matter has been referred to the Lighting Committee.

Eastbourne.—The Eastbourne Electric Light Company has arranged to carry out extensions of their system in Grove, Terminus, and Cornfield Roads, and Burlington Place. Permission has been granted by the Council subject to the usual conditions.

Edinburgh.—Last Friday evening the electric light was turned on in the premises of Messrs. Smiths & Co., electrical engineers, 89, George Street, Edinburgh, which have just been fitted. The installation has been made "to enable the public to see the general effect of the light, and to allow them to choose and select fittings when in operation." The motive power is obtained from an oil engine. The engine is connected by a belt to a compound-wound dynamo, which supplies current to 43 incandescent lamps of 16 and 32 candle-power, and two Brockie-Pell arc lamps of 2,000 candle-power each.

Farnworth.—Some of the members of the Local Board complained the other day that the Electric Lighting Committee is never called together. The General Purposes Committee were to discuss the matter yesterday.

Fermoy.—At a recent meeting of the Commissioners, the clerk read communications from the following regarding the proposed scheme for lighting the town by electricity:—

Mr. Wm. Murphy, Dublin.
Messrs. New & Mayne, London.
Morgan, Williams & King, London.
Edmundson & Co., Dublin.
The Electrical Installation Company, Westminster.
Crompton & Co., Chelmsford.
Roger Dawson, Limited, London.
Walter M'Farlane & Co., Glasgow.
Mr. Hammond, London.
Thos. Tomlinson, Bray.

The Electrical Installation Company stated that one of their engineers would be in Cork shortly fitting up Donnybrook Fair with 800 electric lights, and would gladly go to Fermoy and confer with the commissioners. The commissioners decided to avail themselves of the offer. Mr. Thomas Tomlinson, engineer to the Bray Electric Lighting Company, wrote stating that for an interview at Fermoy, after examination of the town and collection of information on the previous day, he would charge £5 5s. and expenses. For additional examination, the preparation of reports, with plan and estimate, and an interview following the presentation of the report, he would charge £15 15s. and expenses not exceeding £5. The Board considered the charges reasonable, and decided to request him to attend at his earliest convenience.

Folkestone.—The electric light has been installed in the parish church by one of the local tradesmen, who has his own dynamo and apparatus. At the Council meeting on Wednesday, attention was called to the fact that overhead wires had been established and pavement taken up without sanction, and a resolution was adopted calling upon the Board of Trade to take the necessary steps against the parties under the Electric Lighting Act of 1888.

Glasgow.—The Royal Exchange Sale Rooms, which are leased by Messrs. Robert McTear & Co., have been lighted throughout by electricity, including galleries, sale rooms, and offices.

Great Yarmouth.—At the Town Council meeting on Tuesday, it was decided to light the Town Hall electrically, the surveyor estimating the lowest possible cost at £300.

Haverfordwest.—Recently the trial of the electric light took place at the New Ice Factory, built for Messrs. Neale & West, on Milford Docks. The installation of the building was carried out by J. C. Howell & Co., Limited. The illumination proved a great success, not a hitch occurring. The dynamo is of a late "Crompton" type, and the installation comprises 64 16-C.P. lamps, and two sunbeam lamps outside, of 200 C.P. each.

Heckmondwike.—At a recent meeting of the Local Board, so says a local paper, the clerk read a letter from the Mayor of Hereford "asking for particulars of electric light installation provided by the Board under their order in 1891. He wanted the information for the guidance of his corporation, who are about to introduce the light. Mr. Wood moved that the Clerk reply to the effect that in consequence of the successful opposition of the non-progressivists of the town the progressive party were defeated, and the introduction of the electric light was therefore a thing of the future. Mr. Redfearn moved that the clerk furnish the information asked for, which was seconded by Mr. Hooper, and carried." The laws governing local boards are fearfully and wonderfully made, but what puzzles us is the ability of the Town Clerk to furnish the required information when the electric lighting of the district is yet an affair of the future.

Hereford.—The Great Western Electric Light and Power Company have given notice of their intention to apply for a provisional order for lighting the district by electricity. The Town Council thereupon discussed whether it would not be advisable for themselves to apply for such an order, but they ultimately decided to defer the matter for a few weeks.

Hull.—Electric lighting is to be adopted in the police court at an expense of about £10. The Chairman of the Property Committee said the other day that he had a firm conviction that the electric light would not last long in Hull, and the fittings would have to be taken down again in 12 months. We consider the statement was thoughtlessly made, or the speaker's mind was governed by prejudice.

India.—According to an Indian contemporary the public of Calcutta is greatly interested in the introduction of electric lighting, and now that it is known that the wave of enterprise is stemmed by the proposal to legislate in the matter, the enquiry is pretty general as to when the Bill is likely to be passed.

The Indian Telegraph report for 1893-4 has been submitted to Government. It is believed that, excluding the cost of free and State messages, the interest on the capital is 2½ per cent., the highest yet paid. Including the cost of free and State messages, the profit is about 4¾ per cent.

We understand that the electric light is being largely adopted in Colombo.

The United Service Club, Calcutta, has been fitted up with the electric light.

Ipswich.—The Town Council decided at their meeting on Wednesday, the 10th inst., to adopt the Hermite electrical sanitation process. This decision was unanimous, and resulted from the exceedingly favourable report submitted by the Sewerage Committee on the trials which have been made on the main sewers of the town during the last three months. We understand the permanent installation is to be proceeded with as rapidly as possible.

Ireland.—Mr. Maurice Pitman, A.M.I.E.E., of Sandymount, Co. Dublin, has secured the contract for supplying and fitting up the new drawing room car saloon for the Great Northern Railway Company (Ireland) with 18 incandescent lamps, including all fittings, &c., and E.P.S. accumulators. This carriage is to be fitted up so that it may be lighted either by its own accumulators, which are charged by a stationary engine and dynamo, or be attached to the 5.30 Dublin to Belfast express, which has its own complete plant, consisting of dynamo, driven off guards, van axle, accumulators, &c., which contract was carried out under Mr. Pitman's personal supervision, and has been running for the last 18 months very satisfactorily.

Kingstown.—A telephone lineman was working upon a telephone pole at Kingstown (Ireland) last Friday when he fell a distance of 52 feet, and it was found necessary to convey him to the hospital, where he was detained.

Larne.—According to a Belfast paper some members of the Municipal Board are "complaining bitterly" of the state of the electric lighting arrangements in the town. A number of the lamps have been out lately leaving portions of the town in total darkness. In reply to these criticisms it is stated that the electric light company are doing their best, and a little forbearance is asked for.

Leeds.—Last Friday evening the illuminations were most extensive. At the stroke of eight o'clock five search lights were switched on in the tower of the Town Hall, and some 14 other search lights were also illuminating various parts of the city, these being made by Mr. F. J. Borland of Leeds. There were also a number of electric lamps decorating the various buildings, &c.

The new medical school and the college hall of the Yorkshire College, at Leeds, were opened on Friday last by the Duke and Duchess of York. The building is lighted throughout by electricity, the entire installation having been carried out by Mr. T. Harding Churton, of Leeds.

Leyton.—The Electric Lighting Committee have reported that the provisional order granted by the Board of Trade had been confirmed by Parliament, and the time for carrying out the works had been extended to three instead of the usual period of two years.

Liverpool.—At the City Council meeting, a member recently called attention to the lighting of St. George's Hall and the Municipal Buildings, urging that the time had now arrived when the electric light should be employed. Alderman Radcliffe explained that the matter had not escaped the attention of the committee. The only question was which scheme to adopt, and this would be decided upon after experimental tests.

London.—At the London County Council last week it was stated that a notice had been given by the Notting Hill Electric Lighting Company of intention to lay mains in and across Addison Road. The proposed works were of the ordinary character, and the sanction of the council was given to the works referred to, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works, and that the street boxes be of a pattern approved by the council. The Kensington and Knightsbridge Electric Lighting Company had given two notices of proposed extension of mains in Prince of Wales Terrace and in Gloucester Road. The sanction of the council was given.

At the Goldsmith's Institute, New Cross, recently, the inaugural address of a series of lectures on "Gas Manufacture" was given

by Mr. Geo. Livesey. He stated that in South London the amount of gas consumed had doubled within the last 15 years, notwithstanding the competition of petroleum and the electric light. We venture to predict that at the end of the next 15 years this statement will not apply.

Whitechapel District Board of Works last week discussed the report of the Streets Committee with regard to the scheme for lighting the district electrically. The whole question was referred back for further consideration.

Lowestoft.—The Town Council, on Tuesday night, considered a letter that had been received from Mr. F. H. Medhurst, electrical engineer, with reference to conferring with the committee on the subject of the electric lighting of the borough. The council decided to confer with Mr. Medhurst at their meeting on 23rd inst.

Lynton.—The clerk has been instructed to ask Mr. Benn, manager of the electric lighting company, when he will supply the additional light which he promised some time ago.

Montrose.—Mr. Whiteman has given notice that at the next meeting of the Council he would move that the Council do all in their power to support the Scottish House-to-House Electric Lighting Company, Limited, in applying for a provisional order to supply electric light to the burgh.

Motherwell.—The Police Commissioners have adopted a report by Mr. Henry A. Mavor, electrical engineer, Glasgow, showing the estimated cost of lighting the streets at £12,500, including cost of provisional order, and calculating that, with the saving effected and the income from private lighting, there will be no increase in the rates.

Munich.—Herr Lautenschläger, chief machinist at the Royal Opera House, has devised a system of moving the scenery, raising the curtain, and performing other heavy stage work by electricity. Various experiments which have been in progress for some time past, under the direction of the Bavarian Court officials, have been so successful, that it has been decided to use electric motors in nearly every department of the stage.

National Telephone Company v. Robson.—At Belfast the other day, the National Company brought an action in the Recorder's Court against Mr. John Robson, to recover £10 for hire of a telephone, &c., for the year commencing July 1st, 1894. On May 31st defendant gave notice to the company to remove the telephone on or before July 1st. He complained that the apparatus had not been kept in order, and had proved a regular nuisance. After a very lengthy hearing, the judge dismissed the case on the ground that the company were not entitled to maintain the action.

Newcastle.—The Town Council have for some months had under consideration the recommendation of a committee that a cable tramway system be adopted. At last week's meeting further details regarding the scheme were placed before the council.

Norwich.—The Chapel-in-the-Field, the interior of which has been recently rearranged and improved, has also had electric lighting added. Three of the large central gasaliers have been converted into elegant electroliers, frosted glass being used. Eleven suspended lights have been placed under the galleries, and other similar lights have been scattered about the entrances, lobbies, and vestries. Two arc lamps have been temporarily placed at either side of the entrance. The schoolroom and the class-rooms adjoining have been installed on the same principle as that of the chapel. Messrs. Laurence, Scott and Co. carried out the work.

Nottingham.—The electric light was used at Castle Gate Congregational Church for the first time on Sunday evening last. The work connected with the installation was carried out by Messrs. Thos. Danks & Co., of Nottingham. The fittings include eight brass electroliers, each carrying eight 16-C.P. lamps, in the body of the church; one 12-light electrolier for the gallery; one 6-light and two 3-light electroliers for the organ chamber, and a number of others under the gallery. The total number of lamps is 132 16-C.P.

Peterborough.—The borough engineer has received instructions from the Town Council to prepare a report upon the steps to be taken under the provisional order, which gives the Corporation power to supply electricity within the borough.

Poplar.—A letter from the Board of Works, asking the guardians whether, in the event of the Board installing the electric light in the district, they would be prepared to take the same for their premises for a stated period, has been referred to committee.

Portsmouth.—The Town Council has authorised application to be made to the Local Government Board for permission to borrow £60,000, to carry out the installation contemplated. The estimate was made up of £56,385 for land, engines, dynamos, cables, &c., and £3,615 for capital and contingencies, &c., the capital being intended to be used for house service, &c. The Local Government Board sanctioned the former, but struck out the latter, with the intimation that it could be had from time to time, as required for those purposes. Since then two sums of £550 and £1,265 have been sanctioned for extensions in Russell Street, South Parade, Clifton Road, and the Drill Hall, bringing the full amount up to £58,200. The Electric Lighting Committee further reported to the Council:—"Besides which your Committee have now joined up 160 house services, at an average cost of £10 per house, which sum it will now be necessary to borrow. Your committee, therefore, recommend that the application be now made to the Local Government Board for permission to borrow £1,800, the remaining balance of the £60,000, which will leave a small sum in hand for immediate necessities." A statement of estimated income and expenditure from September, 1894, to September, 1895, has been prepared by the Committee, showing the receipts to be as follows:—Street lighting, £1,800; private lights, £5,000; total, £6,800. After payment of interest and amount for sinking fund—£3,400—and expenses, it was estimated that there would be a balance of £257.

Exeter.—The Albert Museum, Exeter, is lighted by electricity, and last week James Martyr, the caretaker, was engaged with Mr. Harvey, of the firm of Tait & Harvey, architects, of that city, in the cellars of the building, when a conversation took place with respect to the lighting of the premises. Martyr explained how the current of the electricity was turned on and off, and proceeded to interfere with the switch which connects the supply of electricity. This should never be meddled with except by the *employés* of the electric light company, who issue notices to this effect to the customers, and a copy is posted in the museum cellars. At the time that Martyr touched the switch the current of electricity was turned on, the result being that he received a severe shock, and it is surprising that he was not killed on the spot. The current, however, was sufficient to burn Martyr's hands severely. He was removed to the Devon and Exeter Hospital, where he has been under treatment. It is stated that the lock of the iron cupboard where the switch is located, and of which the electric light company has the key, was missing at the time the accident occurred.

Redditch.—At last week's meeting of the Local Board the report of the Electric Lighting Committee, who had engaged Mr. J. A. McMullen to prepare a scheme and ascertain the cost for lighting the town with electricity was presented. Two schemes were suggested. The first was to provide 1,500 candle-power lights at an estimated cost of £7,000 or £8,000, and the second was to provide 4,000 lights at an estimated cost of from £13,000 to £14,000. It was found that the first scheme, with a charge for the light equivalent to that paid for the Redditch gas, would more than pay all expenses. The second scheme would result in at least £1,200 per annum profit. The committee suggested that as soon as promises to use from 1,500 to 2,000 lights had been obtained, a provisional order should be applied for, but as the new Council would be shortly elected, it would be advisable to postpone the decision, so that the Council could thoroughly examine the schemes before being committed to any expenditure in the matter.

Shoreditch.—As we stated a few weeks ago, the electric lighting scheme has been shelved for the present. From the local papers it would appear that the promoters of the proposed scheme accused the opposition parties of allowing impure motives to stand in the way of it. These assertions called forth an able reply from Mr. Protheroe, contradicting the statement *in toto*. The sole reason for the opposition has been the enormous expenditure necessary and the present high taxation. One of the vestrymen told us a few weeks ago that he, and a number of his friends on the Vestry, were determined to fight the scheme tooth and nail, though they were not very hopeful of succeeding. They, however, set to work determinately, and won the day by a majority of seven votes. It is to be hoped, when the new members are elected, these numbers will be reversed, for Shoreditch is a district which is much in need of cleansing and enlightenment, and sooner or later some such scheme as that which has just been deferred must be adopted.

Southport.—The Electricity Committee have resolved to illuminate the public buildings and fountains on the inauguration of the electric light on November 9th and 10th, and Councillor Boocock has given notice to move that the electric lighting of Lord Street and the Promenade be at once agreed to. The Halls Committee have accepted tenders for the electric lighting of the Cambridge Hall and the Town Hall at a cost of £862.

Stevenson.—The iron and steel foundry works of Messrs. Maurice Donne & Morice, Limited, are to be lighted by electricity.

Suffolk.—Barton Mills, near Mildenhall, have lately been lighted by electricity, the installation being carried out by Messrs. W. J. Crampton & Co., of Cambridge.

Teneriffe.—The town of Orataka, at Teneriffe, Canary Islands, is about to be lighted by electricity, a central station, driven by water power, now approaching completion there.

Walsall.—On Monday night one of the overhead wires for the electric trams broke on the Bridge just as a pony and trap containing two men were passing. The wire fell upon the vehicle and injured both the men and the pony, but not seriously.

Wells.—The Town Council had before them the question of granting the application of Mr. Dixon Brown for a provisional order for electric lighting. A resolution was moved to the effect that Mr. Brown be informed that the council had the matter of electric lighting under consideration themselves, and the matter be referred to the lighting committee for consideration and report. An amendment was also moved granting Mr. Brown consent. For each motion there were six votes, and the Mayor gave his casting vote in favour of the original resolution, and very wisely refused to take into consideration the vote of a member interested in the gas company, notwithstanding that member's threat to contest the justice of the Mayor's ruling.

West Cowes.—The Local Board have refused to consent to the application which had been made to them for laying a cable in Bath Road.

(*Continued on page* 446.)

THE ELECTRIC MOTOR AND SOME OF ITS APPLICATIONS.

(Continued from page 410.)

Motors on Public Supply Systems.

It is not very long ago that a certain amount of controversy existed as to the advisability of putting electric motors on to public lighting circuits. The motor was by some put forward as the one specific to improve the day load; others urged that complications and trouble would arise by placing motors on the lamp circuit. A certain amount of reason probably exists in both these views. No matter which is more nearly realised, there is one thing patent and that is the troubles which were said would inevitably arise have been greatly exaggerated, and they have decreased with an increased output. We may quote as an instance St. Pancras, where, in the early days of the station, motors undoubtedly gave considerable trouble, but as the output of the station increased they became less and less, until, at the present moment, they have completely disappeared. In the large American stations where lights and motors are intermingled at haphazard, disturbance to the lights are quite unknown. Indeed, we are given to understand that such is the flexibility of some American supply systems that motors are frequently run by stolen current.

There were many central station engineers who looked with disfavour upon the introduction of motors upon their systems. It was not altogether to be wondered at, for the motor carried with it great powers of mischief. We well remember the alarm and consternation which prevailed for some time in one lighting district by the illicit introduction, by an enterprising consumer, of a several horse-power motor on to the supply system. The ambitious user of electric current had omitted to inform the central station folks of his intentions, and as his arrangement was absolutely innocent of any form of resistance, the effect throughout the district was vividly realised; the engineer was startled, and the machines paused to reflect.

The Bradford supply system is, perhaps, the most conspicuous example of the running of motors from a central station. There are over forty motors in use, and they are used for all kinds of purposes.

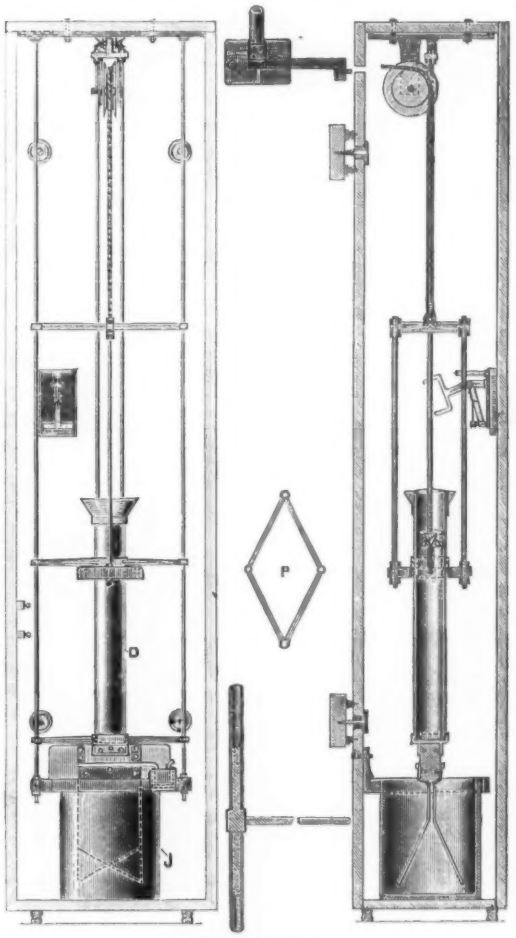
One of the difficulties which the consumers originally experienced at Bradford was the starting of the motors. The starting resistance regulated by hand gave a good deal of trouble; often when part of the resistance was left in circuit it was melted when the load was put, or if cut-out too quickly the Corporation fuses were frequently blown. To make the use of the motors as popular as possible by simplifying their use, Mr. Sydney Baynes, the Corporation engineer, designed an automatic time-starter with acid resistance; this is released and requires 30 seconds to put on full power.

With the following details and the annexed drawings, a notion may be gleaned of the action of the switch. The dashpot, D, is filled with glycerine diluted, as required, with water. The stoneware jar, J, fitting into the cast-iron ring at the bottom of the box, is filled with water with about one-half teaspoonful of sulphuric acid added.

There is a light frame, with cast-iron ring, which is carried by a flexible steel or copper cord running over a pulley and fixed to a vertical shaft, with a crank at lower end to carry the said cord. This shaft runs up through all the floors (if it is required to stop and start from each floor), and on every floor a handle extends from the shaft. To start the motor, the handle is pushed round, which turns the shaft and lowers (by gravity) the light frame, and as there is no further support for the dashpot and plates, they descend slowly into the acidulated water. There are two mercury cups, cast in the ring, which surrounds the stoneware jar, two copper points enter the mercury (when the plates are immersed) and cut the plates out of circuit. As the plates commence to descend, and before touching the acid water, they engage in the shunt switch (marked in the drawing) and turn on the shunt current. The reverse movement of the lever rod on any floor raises at once the plates, knocks off the shunt switch and stops the motor. This is done practically without loss of time, and there is no jumping when cutting off current from a motor. A valve, shown in the plunger of the dashpot, allows the glycerine to pass freely when being pulled up sharp.

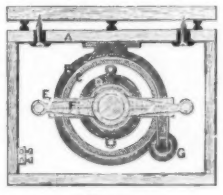
There are now a number of these switches in use at Bradford which work successfully. Similar switches have been sent to Manchester and elsewhere.

The Baynes Switch.

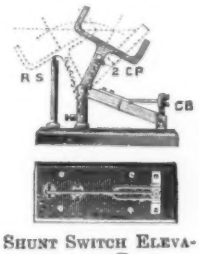


D, Dashpot; J, Earthenware jar.

Elevation. Sectional Elevation.



Plan.



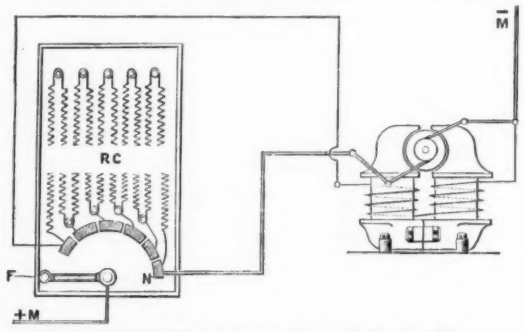
Shunt Switch Elevation and Plan.

A, Wood case insulated, B, Iron casting with mercury cup; C, Earthenware jar for acid solution; D, Movable weight for taking up slack cord; E, Wood (teake) block to carry lead plates; F, Brass guide pinned and sweated on to dash pot; G, Glass to hold mercury; R S, Rubber stop; C B, Carbon break; C S, Two springs copper plated.

Another trouble experienced at Bradford arose when cranes started to lift a dead weight, the motor under such circumstances would momentarily pull up, the shock being felt all over the system. Mr. Baynes got rid of this by insisting upon an efficient fly-wheel on every motor. It is interesting to record Mr. Baynes's opinion on the use of motors on supply systems, which is, that without a good accumulator on the circuit it is possible to deal with the motor business.

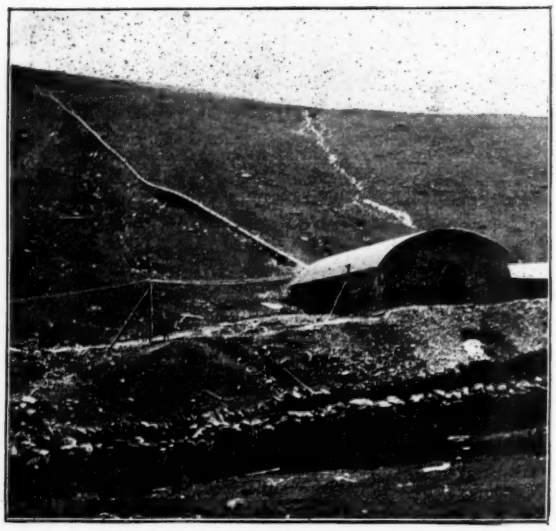
Motors are used to a fair extent on the Norwich Electric Light Company's circuits, many of these being supplied by Messrs. Laurence, Scott & Co. Shunt motors are used to a great extent and the method of starting is worth recording. The annexed diagram is to some extent explanatory. One end of the shunt winding is brought to a small special terminal on the machine, and this terminal is connected to the first contact of the resistance switch, so that when the lever of the resistance switch comes on to this contact, the whole

pressure is put on to the field magnet coils, although the current to get to the armature has to go through the whole of the resistances in the switch, and as these resistances are



Laurence-Scott Method of Starting Shunt Motor.

switched out of the armature circuit, they are put into the field magnet circuit; but owing to the high resistance of the



Greenside Silver Lead Mine.

field magnet circuit, they have practically no effect on it, as they only increase the total shunt circuit resistance very slightly. On switching off there is no trouble with the shunt coils, as the shunt circuit is never broken, but remains completed through the resistances and the armature. It is found that these resistance switches act perfectly, and enable the shunt motors to be started quite easily, even on a load. Of course, if these starting switches are rushed on too suddenly, the voltage on the main suffers, and the motor receives a very severe jerk. To obviate the chance of this being done, Messrs. Laurence, Scott and Co. have made and supplied, in many cases, an excess cut-out which automatically puts in a resistance when too much current is being taken by the motor, and also automatically short-circuits this resistance when the motor has increased in speed so that the current diminishes.

In the St. Pancras district at the end of August there were 22, representing 70·6 H.P.; they are used for joinery purposes, hoist, chaff cutting, stamping machinery, hair dressing, ventilating, printing machines, lathes, and workshop tools.

The charge of 3d. per unit during the day when the plant is standing idle is considered satisfactory, as it pays for coal, oil, and wages.

From Mr. Baron's experience in this parish, he considers that the industrial application of electricity to motive power is looked upon with favour by small power users, and especially if it be required for intermittent purposes.

A number of firms have settled their works in this parish on that account alone.

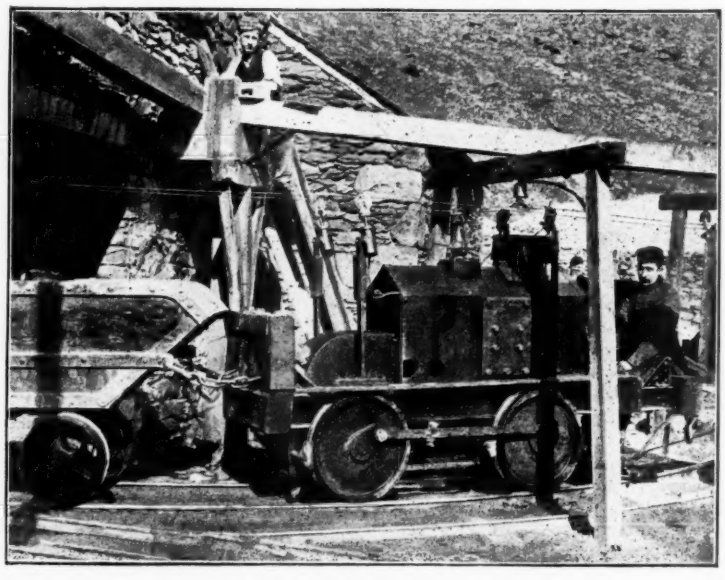
By putting the motors on the two outside wires, Mr. Baron has some hope of getting rid of the variation which has been the trouble in running motors on lighting circuits, and also by a judicious use of resistance on starting up, so that there is not the jerk which is so often felt and complained about.

Electricity in Mines.

We have indicated elsewhere that to deal adequately with the use of electricity in mining operations, would need a greater demand on our space than we can well spare in this *résumé* of motor work. At the same time we feel that the importance of this application of electric motive power merits more than passing mention. The transmission of electric power at the Greenside Silver Lead Mines is a most interesting scheme. It is also a large one, being of 100 H.P. We give an illustration of the generating station, which is situate about a mile and a-half from the first motor.

The generating plant consists of a "Vortex" turbine, capable of giving 100 B.H.P., driving an "Immisch" compound dynamo of the 4-pole type, giving 600 volts, 100 ampères, at 500 revolutions. The water-power is drawn from two natural lakes, near the base of Helvellyn mountain, and taken a distance of 360 yards, through 15 inch cast-iron pipes, to the dynamo house, which is situated in the valley at the foot of the mountain.

About 1¼ miles from the dynamo, bare overhead wires carrying the current, is situated an "Immisch" motor, driving a winding drum, 5 feet diameter, hoisting a load of 10 cwts., at a speed of 360 feet per minute. About 350 yards further away, another "Immisch" motor is fixed, driving a three-throw horizontal ram pump, for forcing the whole of the water in the mine, 120 yards high in one lift, to another level. Midway between these two motors, a continuous current transformer is fixed for reducing the E.M.F. to 200 volts to supply an "Immisch" locomotive, illustrated herewith, which takes the ore through a level, ¾ mile long, to the washing grates. The load averages 12 tons and travels at about 4 to 5 miles per hour.



Electric Locomotive.

The contractors for the whole of the plant were the General Electric Power and Traction Company, Limited (now the Acme and Immisch Electric Works, Limited), and the work was carried out under the supervision of Mr. W. H. Borlase, the engineer to the mine. The plant has now been in operation three years, and up to the present has given every satisfaction.

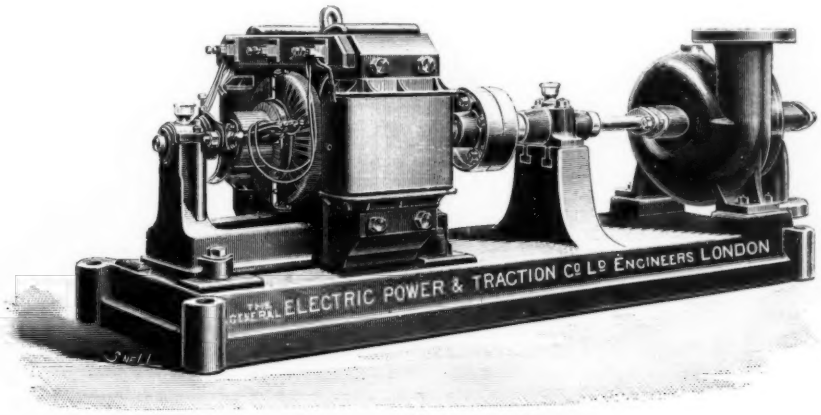
One of the earliest applications of electricity to colliery work was at Messrs. Locke & Co.'s pits at Normanton, a

small pumping plant being erected at these pits in 1887. This was designed to deliver 30 gallons per minute through 530 feet head. Soon after this was completed a larger plant to deliver 120 gallons per minute through 900 feet head was put down. This was started in February, 1888, and has been running practically continuously since then, giving complete satisfaction. The dynamo is of the "Immisch" type, giving 600 volts 70 ampères at 600 revolutions. The motor is of similar design and drives differential pumps with two 6 inch and two 4½ inch rams, by means of belts. The engine is a "Robey" undertype, 30 N.H.P. A week after erection, careful tests of the plant showed the efficiency of the system to be 40 per cent.; 18 months later, this had risen to 43 per cent., due presumably to the decrease of losses occasioned by friction in pumps and engine. The first tests were so satisfactory, that when the pumps had been at work only a fortnight, Messrs. Locke and Co. gave an order for a duplicate set of plant, intending to use the new machines for both hauling and pumping. We illustrate a pumping plant made by the Acme Company.

The similar systems erected by the Acme and Immisch Co. at collieries are too numerous to mention.

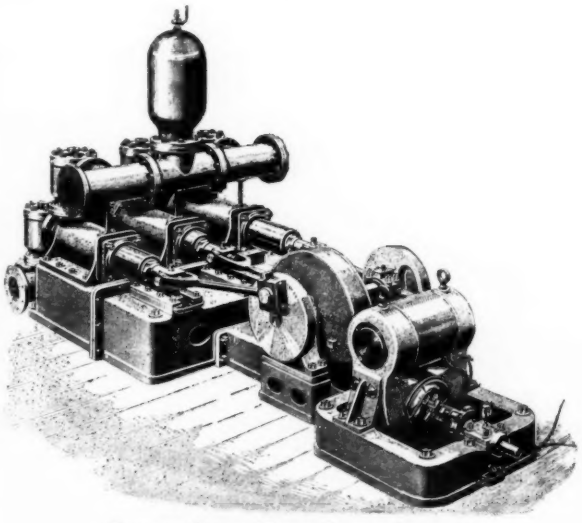
through 1,300 yards of 8-inch pipe, against a head of 50 feet. The motor which drives them gives 20 H.P., when running at its normal speed of 720 revolutions per minute. This speed is reduced to the 30 revolutions, at which the pump shaft runs, by worm gearing, as indicated in the engraving. The worm, which runs in an oil bath, is of wrought iron, and the worm-wheel is phosphor bronze. A thrust bearing is employed to take up the pressure in the worm spindle. The pumps, as will be seen, are three in number. The rams are of gun metal, 9 inches in diameter, and the stroke is 15 inches. The crankshaft and connecting-rods are steel. The dynamo which supplies the current to the motor is at the bank, and the cable connecting the two is 2,700 feet long. A special switch is used at the motor end to prevent sparking at the terminals when starting. The dynamo is belt driven, being designed to run at 800 revolutions per minute, at which its output is 65 ampères at 300 volts. It can be used for electric lighting when not working the pump. The engine which drives it is of the vertical type, having a single cylinder 13 in. in diameter by 10 in. stroke. It is intended to run at 200 revolutions per minute.

One of the best instances of an electric transmission plant



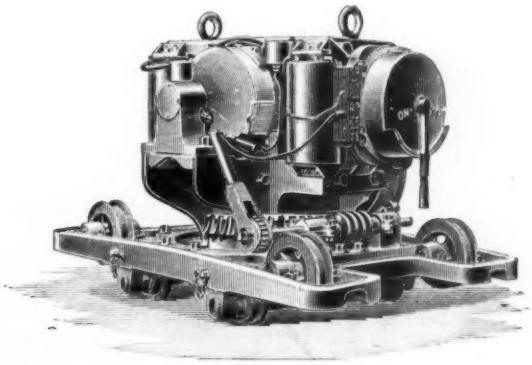
Centrifugal Pump with Motor.

In the collieries of Durham and Northumberland there has been a wholesale application of electricity to mining purposes. One or two schemes carried out by Messrs. Ernest Scott & Mountain will suffice as types. The reputation of this firm is based to a great extent on their practical experience of colliery work, and their knowledge, if measured by the number of schemes they have carried out, must be unique. We illustrate herewith an interesting pumping plant which has been erected by Messrs. Ernest Scott and Mountain at the North Seaton Colliery. The pumps have been designed to deliver 250 gallons of water per minute,



Pumping Plant, North Seaton Colliery.

is at East Howle Colliery. It is interesting to record the reasons which led the engineers of this colliery to adopt electricity, and we are able to do this from a paper read by Mr. Palmer before the North of England Institute of Mining some time ago. Owing to increased feeders in the dip workings it was considered that the water should be dealt with direct instead of pumping with hauling engine ropes.



Electrical Coal Cutter.

At that time the water to be dealt with was about 250 gallons per minute, and it was pumped during the day by the hauling ropes when the set of tubs was running, and at night by the same ropes (5 miles in length) running light without the coal-tubs, and indicating about 170 horse-power. The colliery authorities had to choose between compressed air, a separate rope drive, or electricity. They had had considerable experience of rope pumping, which had convinced them that a further extension was not desirable, so that the choice practically lay between compressed air and electricity. The former method was

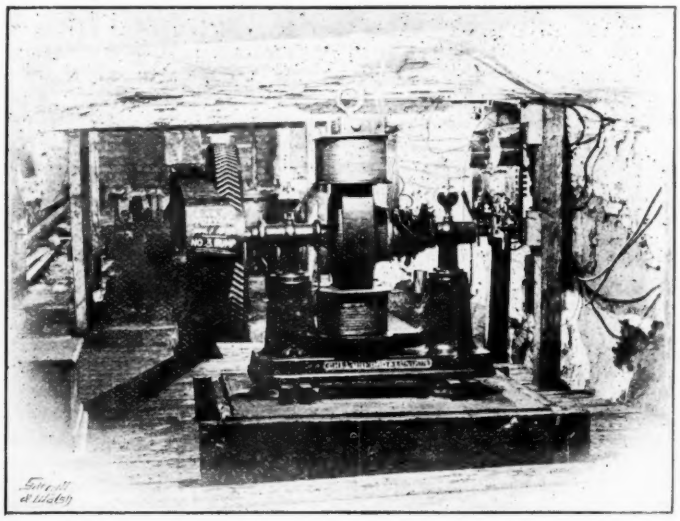
rejected for three reasons: (1) first cost; (2) length of time necessary to obtain and start the plant; and (3) economy. To show that the faith in electricity was well founded it may be mentioned that the order was given on Christmas Eve, and in spite of a delay of three weeks occasioned by frost, the pump was ready for working on March 4th. The generator is a horizontal compound-wound Crompton machine driven by a vertical high speed engine. The dynamo is of special construction but presents nothing very novel. The cable transmitting the energy from the generator to the motor is 3,000 yards in length. Our illustration shows one of the three motors and pumps in use. This has been reproduced from a photograph of the actual plant in position in the workings of the colliery. The whole of the plant has been laid down by the Corlett Engineering Company, of Wigan. It is worth recording that the generating plant runs constantly, excepting two hours' stoppage on Sundays, and the permanent officials of the colliery, with no previous electrical experience, have easily managed the whole plant. At the close of three years' working, the colliery company ascertained that the electrical repair bill for the power plant had only amounted to £12 10s.

A 100 H.P. main and tail rope haulage plant has been erected at the Abercanaid Colliery, Merthyr-Tydvil, by Messrs. Crompton.

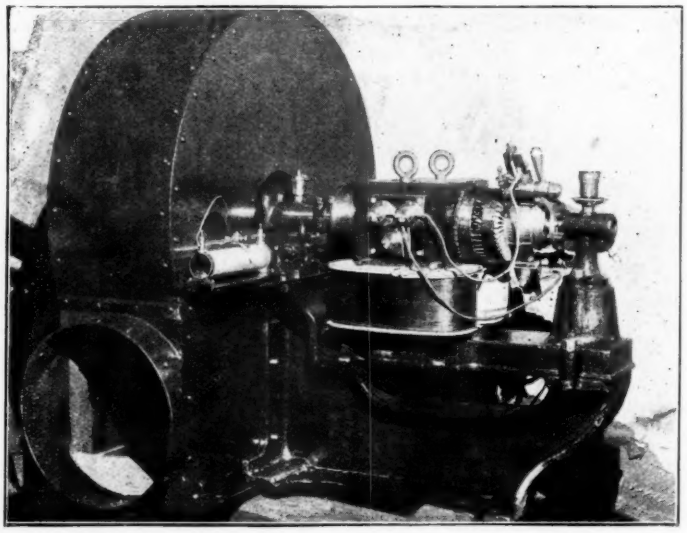
This machinery takes the place of 27 horses and many haulers; moreover, the output has been increased by 100 tons per day. The work here is of the most trying character, but the adaptability of the motor is never for a moment at fault.

Other illustrations show: 40 H.P. winding machine, 4 H.P. fan and motor, and an electrical coal cutter, which have been provided by Messrs. Easton, Anderson, & Goolden, in their numerous plants.

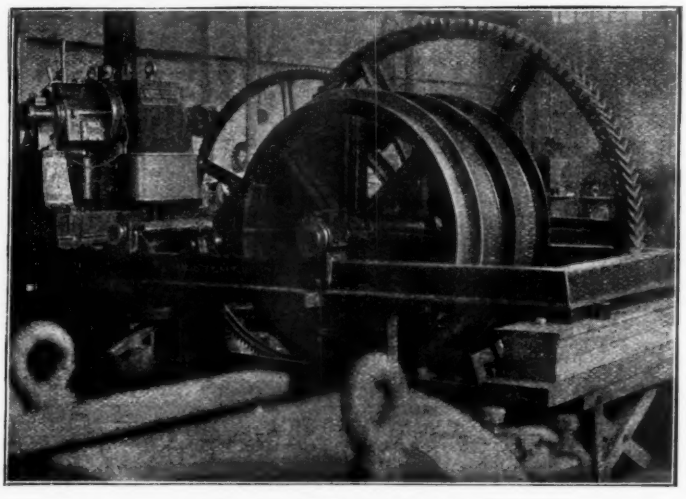
Underground Pump at East Howle Colliery.



4 Horse-power Fan and Motor.



40 Horse-power Winding Engine.



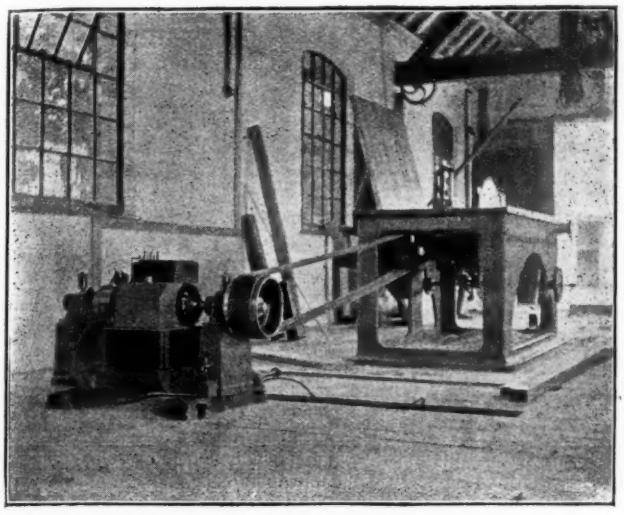
The Use of Small Motors.

One of our illustrations show a motor made for driving a circular saw. It has a drum armature 5½ inches diameter by 7½ inches long, and the magnets have a special winding. The load on a circular saw being very variable, it was essential that a shunt motor should be used so as to maintain a fairly constant speed. A shunt motor, however, is a bad starter, and so a series coil was added to assist the shunt when starting, a switch being provided by means of which the attendant can cut out the series coil as soon as the machine gets up speed. The machine is on a circuit containing accumulators, the voltage of the circuit varying from 100 to 130 according as the cells are being charged or discharged. In place of resistances and switches to absorb the extra 30 volts, the windings of the machine are so proportioned as to reduce the variation in speed with variation of volts to a negligible amount. The current may consequently be switched on to the machine at any time without reference to the voltage of the circuit and without recourse to regulating resistances. The maximum variation of speed from no load to full load and with all voltages from 100 to 130 is about 10 per cent. which is not sufficient to cause any inconvenience in the working of a circular saw. The normal speed of the machine is 1,300 revolutions per minute. The current taken at 100 volts is 27 ampères, and at 130 volts 20·5 ampères. As the saw has a rising and falling spindle it was not practicable to couple the motor to it direct.

This machine has been at work 15 months and was put in by Messrs. Paterson & Cooper.

It is impossible to speak exhaustively on the subject of small motors at the present moment, for it would need a fuller consideration of the question of cost than we are prepared to give at this juncture. On one point, however, we have completely satisfied ourselves, and that is, the use of the small motor is under the majority of circumstances the most economical and the handiest form of power. It must be understood that we are not speaking here of the cases demanding numerous small motors, but are confining ourselves to the single applications.

It is to be regretted that figures relating to the actual cost of power, when using small motors, are few. Doubtless there are existing, here and there, individual tests which are excellent in their way, but we cannot as a general rule say that it will cost so much per hour when using small motors, or that it will cost so much to do a certain piece of work with an electric motor. However, a good deal of attention is being paid to this matter of the economy of the small motor, and we may within a reasonable lapse of time expect to see the question of cost scientifically and adequately discussed. To some it may appear to be a trivial subject, but we firmly believe it to be of the utmost importance.



Sawing Plant, Erected by Paterson & Cooper.

An interesting paper on the subject was read by Messrs. Heap before the Junior Engineering Society last year. It was a contribution, presented in a modest manner, and professed to be little more than a record of the cost of small motors of various powers. We note the authors in dealing with this were confronted with a difficulty which we have experienced at a later date—the difficulty of getting results together.

One of the most interesting tests carried out by Messrs. Heap, was on a saw mill plant at Tring Park. In the first case a Thomson-Houston shunt wound motor drives a 42 inch Standard band saw, the feed of material being 4 feet per minute. It was found that the cost of cutting oak was 0·15 of a penny.

The next test was on a motor driving a 30-inch circular saw, the gauge of saw being 0·116 inch, the peripheral speed when running light being 10,895 feet per minute, and the feed by hand being 13·3 feet per minute. The cost of cutting deal in this case was 0·09d. per foot.

Another interesting test recorded by Messrs. Heap was on a Crompton series-wound motor of 3 brake H.P. driving hoist. This is used for hoisting coal into a bunker on an upper floor, from which it is fed through hoppers into the stokehold. The motor drives through a worm wheel and worm, and single reducing gear on to the drum of the hoist. With it a ton of coal (in 1 cwt. sacks) can be raised in about 10 minutes, including the time taken for hitching the sacks on and off. The cost was 4·7d. per hour.

As a further supplement to Messrs. Heap's tests we have had placed at our disposal some figures showing the cost of working a lift at Messrs. Shoolbred. The figures were taken on two or three different days by Mr. Macdonald, to whom we are indebted for permission to publish them.

Lift at Messrs. Shoolbred's.

Lift Speed = 80 Feet per Minute.

At 6d. per unit a single journey taking one minute, full height of 80 feet, and full load of one ton, costs ½d.
At 3d. rate a single journey, full height and full load, costs ¼d.

Messrs. Heap tested a meat chopping machine and found that the cost per pound of meat, when chopping 110 lbs., came out at the remarkably low figure of 0·02d. per lb. Mr. Macdonald was good enough, for the purpose of this article, to make some tests on a meat chopping machine used at Messrs. Shoolbred's. The ammeter was placed in circuit with the motor and three separate tests were made, each including the starting of motor and machines attached. The first test was with 26 lbs. of meat the second with 18 lbs. of suet, and the third with 26 lbs. of meat. The readings were taken at the end of each minute, and the E.M.F. was 103 volts.

1*st Motor Test.*	
Meat chopped	26 lbs.
Time	5 minutes
Current registered in ampèremeter at end of each minute, 25, 32, 22, 30, 28 = say ...	27 ampères.
2.—Meat chopped	18 lbs. suet.
Time	4 minutes.
Current in amp., 35, 18, 30, 21 = average ...	26 ampères.
3.—Work done	26 lbs. meat.
Time	5 minutes.
Current in amp, 22, 33, 22, 28, 30 = average	27 ampères.

We have, therefore

2·7 units = 312 lbs. of meat.
2·6 „ = 270 „ suet

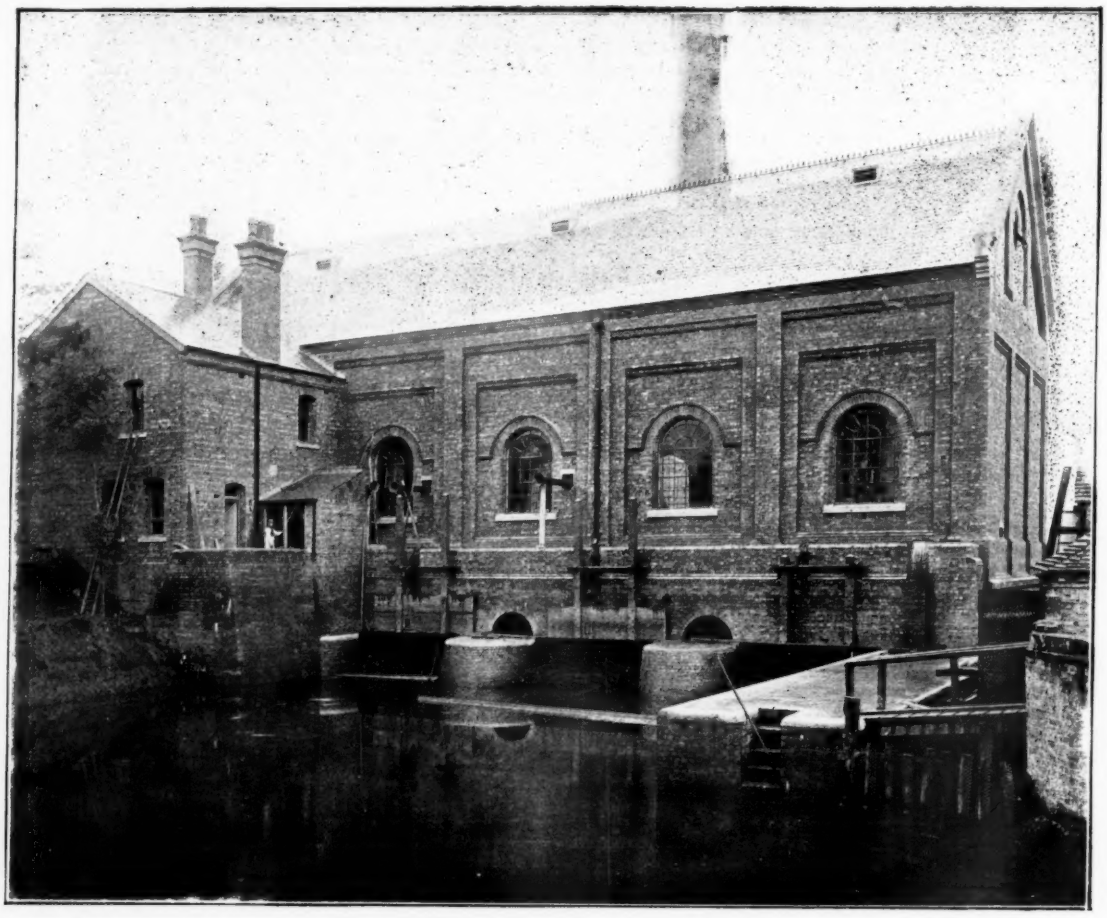
As Messrs. Shoolbred estimate the cost of their own current at twopence per B.O.T. unit, the cost per lb. of meat comes out to the low figure of ·017d. per lb. The cost of current is, of course, low, but taking it at 6d. per unit, the cost per lb. of meat comes out at ·051d., against Messrs. Heap's 0·02. It is only fair to say, however, that Messrs. Shoolbred could obtain current for chopping purposes from the Vestry at 3d. per unit, so the cost per lb. of meat chopped could never exceed ·032d. It should be pointed out that the motor on the above tests was working at somewhat under half its power.

ELECTRIC LIGHTING AT WORCESTER.

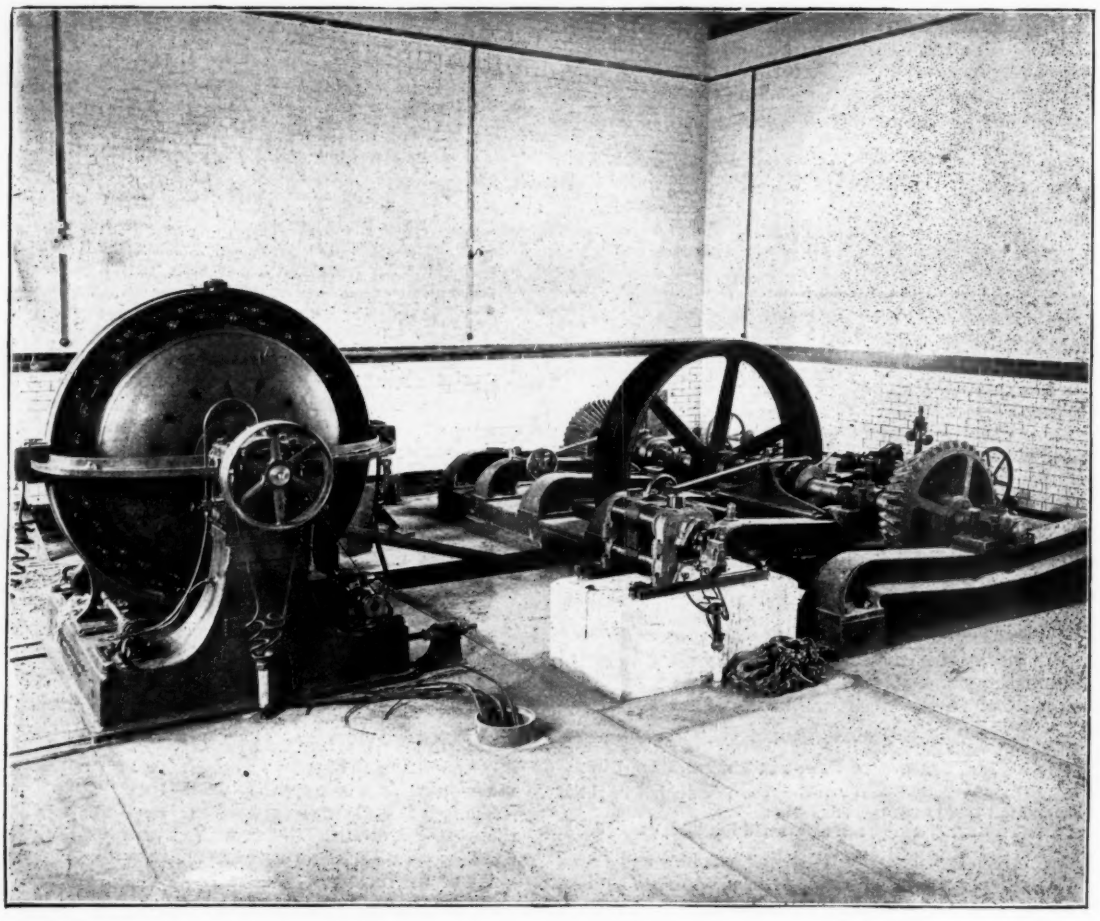
In spite of the accumulated experience gained in central station design during the past few years, we seem by no means to have approached a stereotyped arrangement of plant. True, we have numerous works which follow more or less closely on each other, but it cannot be said that any single one meets with the approbation of every engineer. Yet the battle of the systems has shifted ground to some extent. It is not so much now a "strug-for-life" between low pressure continuous and high pressure alternating currents. There has been some capitulation on the part of the opponents of alternating current, and controversy may be said now to be chiefly concerned with the different phases (not to speak electrically) of alternating current working. The questions of periodicity, rectifiers, direct coupled alternators, among other things, are those which are breaking up electrical men into groups and camps. It is to the ultimate advantage of electricity that there should be this keen controversy, for out of it must emerge systems with their weaknesses effaced. The changes that have been wrought in the science of central stations have not been violent ones. It is true small changes have provoked attacks from the old-fashioned electrical engineers (six years ago constitutes old-fashion in electric lighting), but in all cases the encounters have been bloodless ones, and the representative of "new" electrical engineering has triumphed.

It is scarce two years ago that direct coupling of alternators with high speed engines were said to be impossible, and that the use of rectifiers were denounced as impracticable, and fit only for the scientific laboratory. Yet to-day we see both accepted without murmur. Truly it can be said, that what is new to-day is old to-morrow.

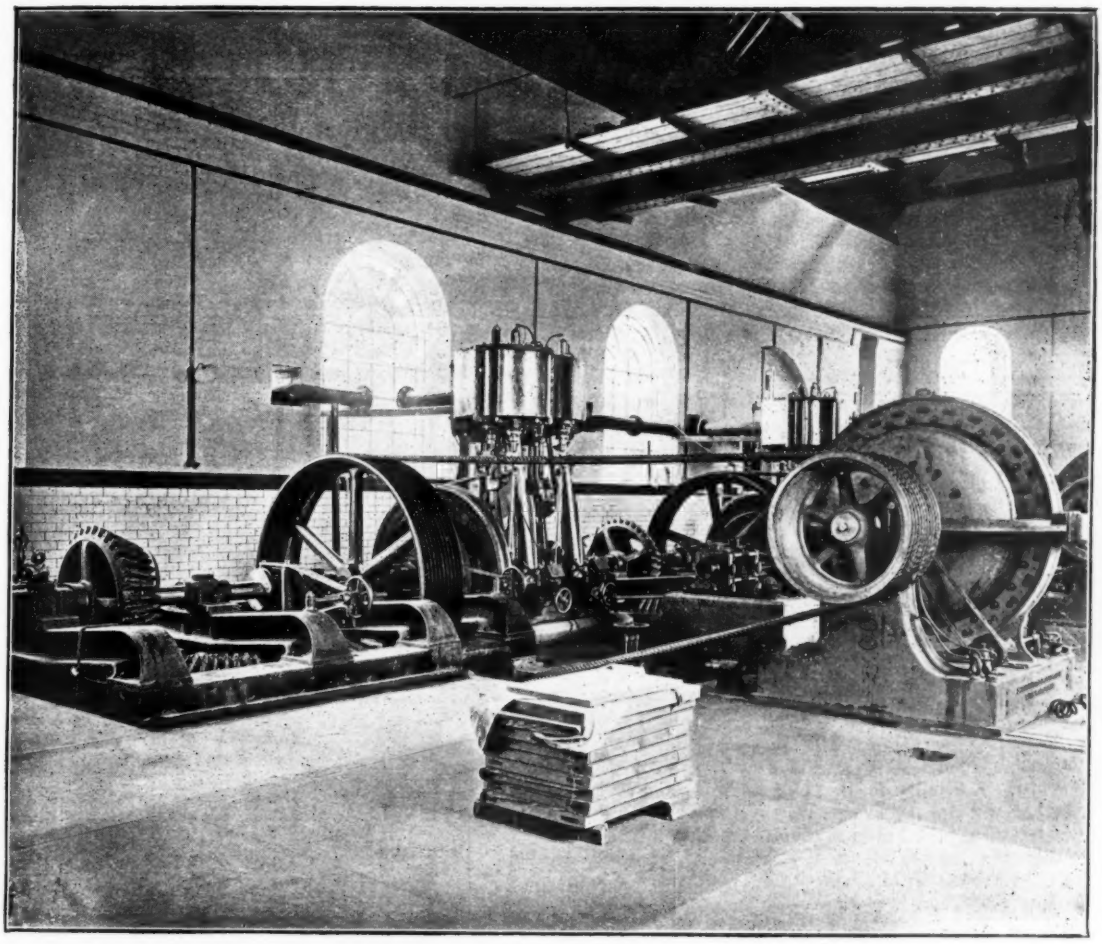
To turn, however, to the Worcester scheme, it may be said that it appeals to electrical men on the grounds that it is the first application on a large scale of water-power in this country. We are not forgetting Keswick, and one or two other cases, but then these were by no means extensive. The water-power at Worcester is to be used in conjunction with steam, but it is clear, in spite of extensive steam plant, that the water-power is expected to fill an important *rôle*. Before considering this, however, we will pause for a moment to speak of the history of electric lighting in Worcester.



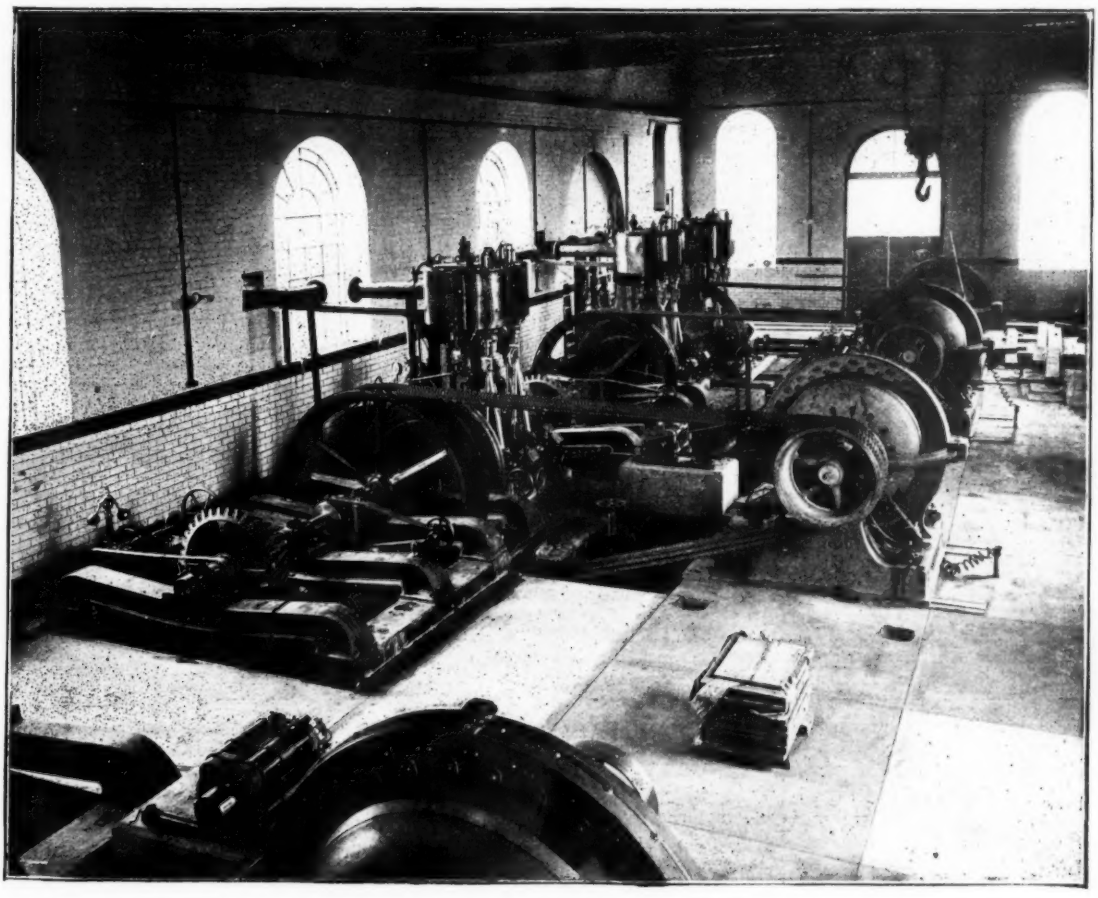
Exterior View of Station, Showing Sluices.



Alternator Driven by 30 and 48-inch Turbines.



The Combined Arrangement of Engine and Turbine Driving Alternator.



General View of Station.

The History of the Scheme.

The use of water-power has been an idea possessed by the Corporation ever since they came to consider the question of electric lighting. It was hoped at first that the water running to waste over the Diglis Weir on the Severn, just below the Cathedral, could be utilised, and with this object in view, schemes were invited from prominent contractors. On the advice of Mr. W. H. Preece, who has acted throughout as consulting engineer, the plan of the Brush Company was provisionally accepted. It was soon discovered, however, that difficulties existed in the way of using the waste waters of the Severn; the trouble arose with the conservators, who insisted on conditions which absolutely precluded the use of water-power. The idea of using this form of power, however, was not abandoned, and after making surveys of the River Theme at Powick, some three or four miles from Worcester, the Corporation decided to buy some existing water rights. It was found, from observations and measurements made by Mr. Purchase, the late city engineer, that the water-power at this point was equivalent to 850,000 effective horse-power hours per annum. To secure these valuable water rights, however, it was necessary to purchase what were known as Powick Mills. These old erections possessed an ancient history, but we will spare our readers a recapitulation of it.

The System.

The system is an alternating high pressure one, derived from a combined water and steam plant. The novelty of the arrangement will be clearly appreciated from our illustrations, which, by the way, have been reproduced from excellent photographs taken for us by Messrs. Bennett & Sons, of Worcester.

The generating station is situate, as we have indicated, on the site of the old mills at Powick; it is practically built across a backwater of the Theme. This will be gathered from our illustration of the exterior of the building, which also shows the sluices.

In the further corner of the generating room are two Victor turbines, of 30 and 48 inches respectively, connected by ropes to a Mordey alternator. They are so arranged that either one or both can drive the alternator. The power of the 30-inch turbines on a 14 feet fall, which is about what is ultimately expected at Powick, is 66 H.P., and that of the 48-inch is 204 H.P. These two, when working together, are equal to the full power of the alternator. It is expected that this combination will be capable of dealing with the entire day-load, but we shall have something more to say on this point later on. In the second pit there is a 54-inch turbine, capable of giving 266 horse-power; this turbine is arranged side by side with a Raworth 286 H.P. engine; either of these can drive the alternator to which they are connected, or, if need be, both engine and turbine can drive the alternator. The transference from either turbine or from engine is made by means of suitable clutches. A second set, precisely similar to the foregoing, is provided, and next to this is a Raworth engine driving an alternator. Briefly, there are four sets, the first one being driven by two turbines, the second and third by engine and turbine, and the fourth by a steam engine. There are three wheel pits and three sets of sluice gates. The turbines are of the vertical cylinder gate type; they are well known, and have been described in the Electrical Review, Vol. xxxi., p. 515. Each turbine is automatically controlled by a Snow governor. This wheel of the turbine receives the water upon the outside and discharges it downwards and outwards, the lines of discharge occupying the entire diameter of the lower portion of the wheel, excepting only the space filled by the lower end of the shaft.

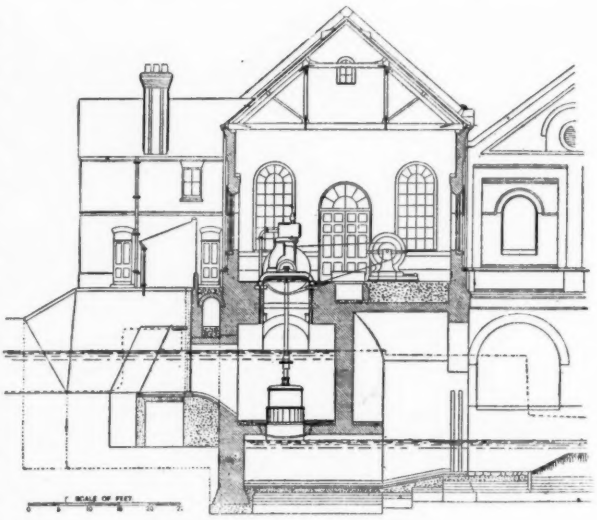
The power is transmitted from the turbines through morticed gearing on to the horizontal shafts, which are coupled to, and run at the same speed as the engines, 160 revolutions. The sluices for the entrances are 12 feet wide in the clear by 8 feet, and are made of timbers 12 feet by 5½ feet. The entrances to the sluices are covered by means of a grating placed across the entrance. We ought to mention, before we go further, that the whole of the turbine work has been carried out by Mr. Frederic Nell, as subcontractor to the Brush Company.

The Steam Plant.

The generating station is a handsomely designed structure, and reflects credit on the architect and on the builder. The lower portion is of course occupied by the wheel pits, the floor above this being the dynamo room, 98 feet long and 36 feet wide. The boiler house is alongside, and is at present fitted with four Babcock water tube boilers, space being left for a fifth. The boilers, which are of 124 H.P. each, are constructed to work at a pressure of 120 lbs. per square inch.

The main steam pipe, which is of wrought-iron, 6 inches in diameter, is in the ring form, with valves so arranged that any portion may be easily isolated without interfering with the working of the engines. The branches, from the main pipe to the engines, are 4 inches in diameter. The valves are of the parallel slide type, which allow of a clear open passage for the steam. Water separators are provided in the main steam pipe, as well as on each engine, which are drained by Geipel's patent expansion steam traps. The exhaust piping, which is of cast-iron, is all 7 inches in diameter, each engine exhausting direct to the atmosphere. It was not thought advisable to adopt condensers, although abundance of water is at hand.

The feed pumps, of which there are two, are of the duplex type, 6 inches by 4 inches with 6-inch stroke. Each is capable of supplying 2,500 gallons of water per hour. They are arranged to pump direct from the river or from a feed tank, which is heated by the exhaust steam from the feed pumps. The feed pipes, which are of galvanised wrought-iron, are



End Elevation of Station.

also on the ring system, being provided with suitable valves for isolating any section. These pumps are also utilised for drawing water from the Theme into the tank for supplying the necessary water service throughout the buildings.

There are three main engines, each capable of developing 286 H.P. They are of the well known Brush compound vertical type, having cylinders 15 inches by 25 inches with 16-inch stroke, and run at 167 revolutions per minute. The high pressure cylinders are provided with piston valves, and the low pressure with ordinary slide valves. Steam is controlled by means of highly sensitive equilibrium governors, and the low pressure slide valves are provided with Hackworth gear for varying the cut-off in the low pressure cylinder whilst running. One engine is fitted with a grooved flywheel for driving one of the alternators; the other two are provided with couplings for connecting each engine to another shaft, which carries the grooved pulley for driving the alternators, this arrangement, as we have already mentioned, being made to allow of their being driven either by the engines or turbines.

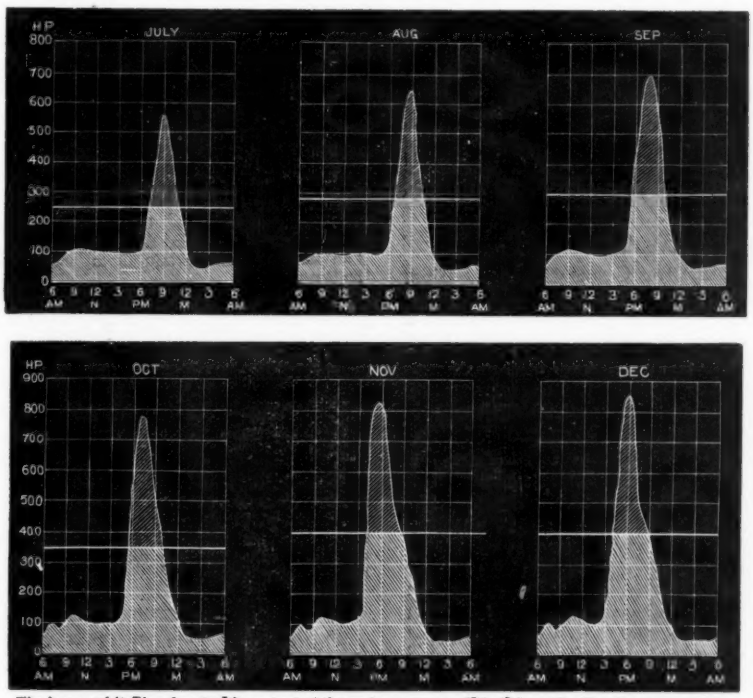
The Electrical Plant.

The alternators are of the well known Mordey type, and call for no special comment. Each has an output of 125,000 watts. They run at 430 revolutions, the working pressure being 200 volts. The lubrication of the bearings is automatic, being effected by means of small pumps, which keep up a constant circulation of oil. The exciting plant is of the usual type.

In the switching arrangements the contractors have utilised their latest improvements in this direction, the object aimed at being to provide such an arrangement of interlocked switches that the possibility of the attendants operating them in an improper sequence is reduced to the smallest limit. We have in a former article referred to this system. Each alternator is controlled by its own switch pillar, which contains a system of interlocked switches making it impossible for the attendant to close the main circuit before the field circuit is closed, and likewise, when the main switch is closed the field switch is locked and cannot be opened before the main switch. These switch pillars are built entirely of cast-iron, and include also the main ammeter, field ammeter, synchroniser switch, and a pair of high tension fuses. Underneath each pillar is placed a rheostat for compensating the change in resistance of the field circuit due to temperature variations. The current from the alternators passes through these pillars on to the main station omnibus bars, one of which, called the inner, runs direct from the pillars to the circuit boards, the other, called

The Method of Distribution.

In the method of distribution adopted at Worcester, there are one or two arrangements which call for some special notice. The electric current is first transmitted from the generating station at Powick to a sub-station at All Hallowes, near the centre of the city, from whence the mains branch off into various directions. What we may term the trunk mains, conveying the current to the city, are two pairs of 19/14's each, drawn into wrought-iron tubes, into which a heavy resinous oil is forced on the Brooks system erected by Johnson and Phillips. At a point between the city and Powick an oil tower has been erected, which gives the necessary head of oil for the mains. A spare tube has been laid to carry an additional main. The trunk mains are taken to omnibus bars, and the various town mains are connected as required. The mains leaving the All Hallowes sub-station are taken to the transformer chambers, which are placed in various districts of the town. At the present moment there are seven of these. The town feeders consist of concentric cables, insulated with specially-treated paper and covered with lead, and drawn into cast-iron pipes.



The heavy white line denotes the extent of the water-power, and that above the line the steam power.

Six Months' Curves Showing Relation of Water Power to Probable Demand.

the outer, being led to the main ammeter board, on which are also fixed the lamps and switches used for synchronising. Switches are provided on this board for shunting the main ammeter when required. From this board the outer main is led through the registering meters to the circuit boards. At present there are only two circuit boards fixed, each containing a main ammeter and double pole high tension switches and fuses. The synchroniser and circuit boards consist of polished marble slabs mounted in handsome wood frames. The whole of the high tension switching arrangements are grouped together and operated from a platform about 3 feet above the engine-room floor, the arrangement greatly adding to the general appearance of the alternating room. For controlling the exciters, there is provided for each machine one of the Brush Company's latest type of exciter pillars; this contains Raworth's patent switch for automatically closing and opening the circuit of each exciter according as its E.M.F. is sufficient for supplying the circuit; so that to switch an exciter into circuit, it is merely necessary to open the steam stop valve, while it is switched out of circuit by merely shutting down the steam. Each pillar carries an ammeter and voltmeter, and for regulating the exciters, rheostats are used. These are grouped together and fixed on the switch platform under the main station voltmeter, the exciter pillars being fixed close to their respective exciters.

These have been made by the British Insulated Wire Company. Suitable draw-boxes are provided at various points, and special junction boxes are used for jointing. The low tension mains consist of concentric cables varying in size from ·1 to ·2 of an inch; they are highly insulated and lead-covered, and are protected by steel armouring being laid in the ground direct. The transformers are generally placed in sub-chambers, either under the pavement or on public property. At present there are seven of these, in each of which two or three transformers are placed of the 24 or 36 kilowatt Mordey-Victoria type. At these points the current is transformed from 2,000 volts to 100 volts, switches and fuses being arranged on both sides of each transformer for throwing into and out of circuit without affecting the continuous supply of current. In the outskirts of the city it has not been thought advisable to lay low tension mains, but as the high tension feeders are so easily laid, and at a comparatively small cost, the Corporation have had no hesitation in supplying customers in such districts by means of isolated transformers.

The Street Lighting.

At the present moment the principal streets only are lighted, this being done by a number of alternating arc lamps. They are of the well-known Brush type, with double carbons. They are fixed on ornamental posts and brackets,

and enclosed in japanned copper hexagonal lanterns. A separate main, divided into two circuits, supplies these lamps. The conductors consist of concentric cables, insulated with pure and vulcanised India-rubber, and are drawn into cast-iron pipes. Each lamp has its own transformer placed in the base of the post, in which are also placed impedance coil and switch. The lamps are arranged on alternate circuits, so that half the lamps may be switched out at midnight.

We shall watch with much interest the performance of these lamps, for it seems to us that alternating arc lamps will labour under some difficulties at Worcester. The most successful application of alternating arc lamps made in this country was at Hastings, the lighting being of the most uniform character; but then the conditions here were pre-eminently suitable for such a system, the white fronts of the houses conducing to the happy results. But at Worcester there is little but sombre surroundings, with one or two notable exceptions. At the same time it must be admitted, on behalf of the alternating lamps, that it is a system which is easily controlled.

The Demand.

The Corporation confidently expect that the demand for current in the city will be fairly large. Certainly everything has been done which is likely to foster a demand, and at the outset it is proposed to charge 5d. per unit for night supply, and 3d. for day supply. There are numerous industries in Worcester which might be materially benefitted by using motors, and it is to be sincerely hoped that the famous glove factories which abound in the neighbourhood will seriously consider the use of motors.

A Paying Day Load.

It is not difficult to see that the Corporation are setting much store by the day load, and really it is not surprising when one considers the special conditions which exist at Worcester. By the kindness of Mr. Caink, we are enabled to reproduce some interesting curves, which show what an important part the water-power is going to play. The curves have been determined from a number of exhaustive observations made by Mr. Purchas, the late city engineer, and show the relation of the average water-power to the average demand for power. We have only given the curves for the last six months of the year, for there is practically little variation in the available water-power. Judging from these diagrams, it is manifest that there would not be a single day of the year when the whole of the day load could not be supplied by the turbines, indeed it is not unreasonably expected that the power of the turbines will on many occasions take the night loads. The engineers have hesitated to take this for granted, however, for the number of steam engines provided leave a very large margin.

It will be seen that Mr. Purchas, in drawing the curves, has made all reasonable allowances. Throughout the month of July the water power can be reckoned to yield at least 250 H.P., while in the following month it may be approximating to 300 H.P. Of course, at the end of August, the demand for lighting increases, and though the water power gets higher, it does not increase in the same ratio as the demand for power. Still, the water power increases satisfactorily till it reaches, in December, half of the probable demand. The curves are very instructive, and will well repay consideration. We may expect, with reason, that the cost of generation at Worcester ought to be low. With regard to the day load, it ought to be borne in mind that it is expected to be a good one, for the Corporation have erected at the waterworks pumps which are driven by alternate current motors.

The high tension mains are carried up to the waterworks, and the current is there transformed by means of two 30-kw. transformers to 100 volts, at which pressure the motors are arranged to work.

There are at present two 3-throw horizontal plunger pumps, with rams 6 inches by 15-inch stroke, each set capable of pumping 10,000 gallons of water per hour against a vertical height of 300 feet, through 5,000 yards of 10-inch pipe, at a speed of about 45 revolutions per minute. Each set is fitted with a second motion shaft, spur wheel and pinion, and fast and loose pulleys with striking gear complete. The pumps are placed side by side upon a strong cast-iron bed-plate of sufficient length to take the driving gear. Each pump is fitted with brass suction and delivery valves, glands, and stuffing boxes bushed with brass. The pump rams are of close-grained cast-iron, turned and fitted with guide, shoes, and steel pins. The two motors employed are each capable of developing 30 B.H.P., and are of the alternate current non-synchronous type, running at about 500 revolutions per minute.

In concluding this article, we have to thank Mr. W. H. Preece, the consulting engineer, Mr. Caink, the city engineer, Mr. Wigan, the clerk of the works, and the contractors, for the assistance they have given us.

BUSINESS NOTICES, &c.

(*Continued from page* 436.)

Windsor.—In connection with the establishment of a telephone exchange in Windsor, Messrs. Toomer & Co., of 35, High Street, have made their office a public call office. Communication can be secured with local subscribers, or with London and towns connected therewith, the latter by means of the trunk lines.

Woking.—The electricity supply not being altogether satisfactory of late, a meeting of tradesmen was held last week to discuss what steps should be taken. Mr. Mayne, who was present, explained the cause of the irregularities, and stated that a new engine, which was on order, would put things right. The tradesmen ultimately decided to call another meeting if necessary.

The Sanitary and Lighting Committee reported that Messrs. New and Mayne expected to be able to light the streets, according to their contract, on October 8th. The Lighting Committee have found it advisable to make certain alterations in the positions of some of the lamps.

Wolverhampton.—The Mayor said last Monday that the contract for the installation of the electric light in the town should have been completed on September 18th, but owing to the carpenters' strike and other matters, the work had been delayed. It is expected that the inauguration will take place in a few weeks.

Worthing.—The Council have decided to employ a consulting electrical engineer to furnish plans and information *re* electric lighting.

Wooton-under-Edge.—The present lighting arrangements not meeting with the satisfaction of the ratepayers, they have resolved to petition the authorities to invite tenders for lighting the town. Gas, electricity and oil were mentioned by one of the speakers, who did not care which system was adopted, so long as they get full value for their money.

Aluminium Torpedo Boat.—An aluminium torpedo boat has just been constructed by Messrs. Yarrow & Co. to the order of the French Government. The vessel was taken out for a trial recently. The material of which the hull is constructed is an alloy consisting of 94 per cent. of aluminium and 6 per cent. copper. It is stated that by using aluminium for the hull instead of steel, the speed has been increased by 3½ knots. The alloy has a tensile strength of 14 tons to the square inch.

Bankruptcy.—The failure has been announced at the London Bankruptcy Court of William Hopkin Akester, electrician, late of Glencoe, Crondance Road, Fulham, and now of 897, Fulham Road. The receiving order was made on Monday last upon the application of Mr. H. H. Price, acting on behalf of creditors. No information transpired with regard to assets or liabilities.

Book Received.—"Provisional Orders of the Board of Trade in Reference to Gas and Water, Tramway, Pier, Harbour, and Electric Light Undertakings, being a Manual of Practice for Promoters, Opponents, and Others." By Francis J. Crowther, Parliamentary Agent. Second Edition. Price, 3s. 6d. Published by Jordan and Son, Chancery Lane, W.C.

Braulik v. Sharpe & Kent.—This case has already been reported in the columns of the Electrical Review. The plaintiff, Mr. G. Braulik, claimed the sum of £2 2s. 6d. for electrical goods supplied to the defendants, Messrs. Sharpe & Kent. The defendants' answer to the claim was that the goods were bought "on appro." The plaintiff's traveller admitted having taken the order "on appro.," but he said it was explained at the time that if the defendants wanted to return the goods in a fortnight or three weeks, the plaintiff would be willing to take them back; but the defendants had kept the goods for 12 months. A witness called for the defendants, said that when goods were bought in the electrical trade "on appro." they frequently remained with the intended customer for a period of six months. Judgment was found for the plaintiff for the amount claimed, and costs were allowed.

Cardiff.—Mr. Sydney F. Walker was desirous of extending his works. This was objected to by a Mr. Lynchblosse and his

sister. Mr. Walker thereupon proceeded to obtain the signatures in favour of his proposed extension from residents in the neighbourhood, and the town clerk has now stated that the Public Works Committee, has no power to prevent Mr. Walker carrying out his wishes.

The negotiations with respect to the electric lighting of Redcliff Church have been so protracted that the secretary (Mr. Prosser) was instructed to write to the town authorities to ask for a definite reply as to whether or not they were prepared to enter into an agreement for carrying out the scheme. Applications for the supply of the electric light were received from Highbury Chapel and from Old King Street Baptist Chapel. With regard to the latter a canvass by circular was ordered to be made amongst the tradespeople of Broadmead with the view of ascertaining whether a sufficient number of private consumers would be forthcoming to justify the Lighting Committee in undertaking the extension from Union Street to the chapel. It was reported that the last of the new engines had arrived and was erected, this completing the plant on order. The resignation of the assistant engineer (Mr. Hanson) was accepted, and Mr. R. W. Phillips, of Taunton, one of the selected candidates for a former appointment, was appointed to fill the vacancy at the same salary. Applications from many private residents in Clifton for the supply of the light have been received.

Cassell's "Popular Educator."—Messrs. Cassell have just commenced a new edition of their well-known "Popular Educator." The reputation this book has secured is well deserved. The first part contains a number of papers teeming with sound instruction and interesting reading on subjects, most of which must now be considered essential to a fairly good business education.

Educational.—We have received a copy of the *Record* of Technical and Secondary Education for the October quarter. A number of articles containing some very useful information deal with educational subjects.

Goverment Employés.—The *Evening News and Post* of the 8th inst. protests against the employment at St. Martin's-le-Grand electric lighting station of young students, who work there merely for the sake of gaining experience, without salary, and also of incompetent men, who are paid very low wages, instead of good men being engaged. Our evening contemporary points out the likelihood of accidents occurring through the employment of such inexperienced hands.

London-Ipswich Telephone Service.—The trunk telephone line which has been erected by the Post Office authorities between London and Chelmsford, Colchester, and Ipswich, is now open for public use. A "silence cabinet" has been erected in the Ipswich post office, and three minutes' conversation may be had with Colchester for 3d., with Chelmsford for 6d., with London for 1s., and with Brighton for 1s. 6d. Connections will shortly be made through London with other great towns of the United Kingdom.

Martin v. Binko.—Messrs. C. Martin & Co., 68, West India Dock, Limehouse, sought, before Mr. Commissioner Kerr the other day, to recover the sum of £29 for goods supplied to the defendant, Mr. H. Binko, of 34, Leadenhall Street. The defendant said that the order had not been completed. Judgment was entered for the defendant beyond the amount (£3) paid into Court.

Messrs. Siemens Bros.' Works.—The last vacation visit of the Society of Engineers for the present year was carried out on Tuesday, when about 70 of the members, headed by their president, Mr. George A. Goodwin, inspected the electrical engineering and submarine cable works of Messrs. Siemens Bros. & Co., at Charlton.

Photography by Artificial Light.—The editors of the *Photogram* have opened an exhibition of apparatus to illustrate the process of photography by electric and other artificial lights. The editors are associated in the matter with some of the principal City firms of gas and electrical engineers, as well as the City of London Electric Lighting Company. At this exhibition, the rival systems of gas, electricity, and magnesium lights can be practically compared. It is to be open until October 31st, and is held in the Photogram Commercial Museum, 6, Farringdon Avenue, E.C. Demonstrations are made by experts, and tickets admitting to these may be obtained on application at the offices. Amongst the more notable exhibits are the Houghton reflector arc lamp, the Adamson incandescent electric portrait lamp, the continuous magnesium portrait lamp, several forms of Pilsen arc lamps, Marion's magnesium light, Hart's magnesium light, and Treble's incandescent gas light. Then there are flash lamps in various forms for taking views in mines and other scenes of darkness.

Presentation.—On Saturday, 28th ulto, a smoking concert was held at the Borough Arms Hotel, Cardiff, for the purpose of presenting to Mr. W. H. Powning, of the Cardiff telegraph staff, a testimonial from his fellow officials in recognition of his marriage. The presentation took the form of a purse of gold.

Price Lists.—Messrs. J. Hopkinson & Co., Limited, have sent us a list of their safety boiler mountings. A separate large nicely printed and illustrated sheet deals with the company's patent "absolute" water gauge combined with patent safety shield.

Mr. Ed. Wertheim, of Chicago, the sole agent over there for the Union Carbon Works, Kronach, Germany, has sent us particulars of a life test of various samples of carbon supplied by him. The results are very favourable to the "Union" carbon.

Rust Preventative.—The London Rustless Iron Company, of West Hampstead, have forwarded us a circular announcing that they have established works in that district for rendering iron and steel articles rustless, or rustproof, by the Bower-Barff patent process. If all the circular states be true, the invention is a very useful one. Prices and full instructions are given on the list.

Ship Lighting.—Nearly every new vessel built now-a-days has its own electric lighting installation. Among those recently fitted may be mentioned the following:—New yacht, *Safa-el-Bahr*, for the Khedive of Egypt, built by A. & J. Inglis. Screw steamer, the *Leopoldville*, for the African Steamship Company, launched from the yard of Sir Raylton Dixon & Co., Middlesborough. Steamer, *Bestrataal*, built by Dobson & Co., of Low Walker. Electric light installation by Messrs. J. H. Holmes & Co., who will also supply her with an electric search light for use in the Suez Canal. Steamer, *Independencia*, built by Messrs. Napier, Shanks & Bell, for the Government of San Domingo. Complete installation, including a search light. Steamer, *Ettrick*, built by Napier & Sons. Complete installation. Steamer, *George*, built by Ramage & Ferguson for the eastern Mediterranean local trade. Cabins lighted electrically. Steamer, *Sofia* (sister to the *George*), built by Ramage & Ferguson. Lighted throughout electrically. Steamer, *Oopack*, built by Workman, Clark & Co., for the China Mutual S. N. Co. Complete installation by Messrs. Paterson & Cooper. Steamer, *Amelia*, for east coast service, built by S. M'Knight & Co. Complete installation by Messrs. Clark, Chapman & Co. Steamer, *Ching Wo*, also for the China Mutual S. N. Co., built by Messrs. Workman, Clark & Co. Complete installation.

The Castle liner *Arundel Castle*, in course of construction by the Fairfield Shipbuilding Company, is lighted throughout electrically.

The Indo-European Telegraph Tariff.—The Chamber of Commerce at Madras has, under date September 8th, addressed the following letter to the Government of India (for a copy of which we are indebted to the *Times*), calling attention to the advisability of a reduction in the rates charged for telegrams between Europe and India:—"The Chamber has from time to time pressed upon Government the necessity felt for a reduction of the telegraph tariff between India and Europe. A lecture delivered recently before the Society of Arts, by Mr E. O. Walker, C.I.E., late of the Telegraph Department, has again drawn the attention of the Chamber to the matter, and in view of the approaching International Telegraph Conference, which will assemble in 1896, I am desired to solicit that the Government of India, in furtherance of the object, will use its influence to secure instructions being given to the Indian delegate who will attend the conference to press for a reduction. Setting aside the probability of an increase of traffic following upon a reduction in charge, which has generally been the case, it is thought that the profits made upon foreign telegrams at present are sufficiently large to admit of at least a tentative reduction. For Indo-European messages the share of the Indian Government amounts to something like Rs. 60,00,000 per annum. In addition, the tolls in transit of messages to and from the Far East bring in a rather larger amount. These earnings must amply meet the interest on capital outlay on the circuits, the cost of maintenance, and the wages of the staff employed to deal with foreign telegrams in India, as well as the expense of check, account, and audit; and it is in this view that the Chamber feels that there is a strong case for the consideration of Government. The Telegraph Department may naturally wish to show good results by massing inland and foreign message revenue, charges for railway telegraphs, and receipts from other sources; but the Chamber respectfully submits that when the returns begin to exceed the expenses in any particular direction, the branch of the community which contributes to those returns should receive some remission of charges. It is believed that this aspect of the case will commend itself to Government. As regards the financial result to the Telegraph Department, the Chamber believes that if the tariff were lowered yearly by 8 annas per word to Rs. 2, or even less, there would be no loss. This opinion is strengthened by the fact that it has been possible to reduce, since May 1st, 1891, the rate between England and the Australian colonies (Queensland excepted) by nearly one-half, and the additional traffic attracted by a lower charge has at the present time compensated for the estimated loss of revenue. At first it would appear that a sacrifice was made, but this occurred, doubtless, from too large a reduction in tariff (one-half) being effected at one time, The Chamber advocates a gradually descending scale. Again, when the *minimum* chargeable unit for telegrams with Europe was reduced on January 1st, 1876, from ten words to one word, in the year following, although the average value of such message decreased 12 per cent., private senders despatched 22·44 per cent. more messages, and the gross value of the traffic increased by 5·34 per cent. In the year following that again, the number of messages increased by 38·14 per cent., and the gross value 27·28 per cent. To take another instance which illustrates the contention of the Chamber. Up to January 1st, 1882, a telegram in India cost a *minimum* of one rupee. On that date the 'deferred' class was introduced. In the year 1881-82 private messages in India numbered 1,035,137, and were valued at Rs. 13,16,851; in the year following (when the eight-anna telegram was sanctioned) there were 1,539,975 telegrams, valued at Rs. 26,18,298. Some years ago, the Chamber is aware, the Indian Government had to consider, in connection with foreign tariff, the loss accruing from the Persian lines and cables, that is, of the Indo-European Telegraph Department; but that loss has now disappeared. As regards the Eastern Telegraph Company and the Indo-European Telegraph Company, the dividends now being paid are so good, and their reserve funds laid by out of earnings so large (over £600,000), that the Chamber thinks that these companies may, with propriety, be asked to share the risk of a reduced tariff." It would seem from the above that a gradual reduction has a satisfactory effect as regards increase of traffic, and, as pointed out in this letter both the Eastern Telegraph Company and the Indo-European Telegraph Company are in a position to reduce rates, the reserve funds, laid by out of earnings, being so considerable. Taking the traffic receipts of the Eastern

Telegraph Company for the first six months in 1888, and comparing them with the receipts for the corresponding months of this year, we find an increase of more than £40,000. The desired reduction in rates could, we imagine, be easily arranged, as we have it on Sir John Pender's authority that the Indo-European Company's route is to a large extent owned by the Eastern Telegraph Company; thus there should be no difficulty in coming to terms.

The Practical Electroplating and Enamelling Company, Limited.—At an extraordinary general meeting of the members of the above company, held at the office, Fleet Street, Coventry, on September 22nd, 1894, extraordinary resolutions were passed, winding up the company voluntarily, and appointing, as liquidator, Mr. James Oliver Asquith, of 26, Trinity Churchyard, Coventry.

The Quanonne Lamp.—Incandescent lamps made by Messrs. Quanonne & Co, of Brussels, of which we have heard good reports, are now being advertised at a very low price by the London agents, Messrs. A. and W. Hopkins, of 30, Parliament Street, Westminster. In addition to being a cheap lamp, it is also an economical one in respect of current taken, and, in the words of the makers, they hope it is destined to become a sine Quanonne with all consumers and electricians.

CONTRACTS OPEN AND CLOSED.

OPEN.

Dublin.—October 15th. The Commissioners for the Control of Lunatic Asylums will receive sealed tenders up to 10 a.m. on 15th inst., for supplying two boilers to the Carlow Asylum. Specification can be had on application to the architect, Mr. E. T. Quilton, 24, Leinster Road, Dublin.

Spain.—Tenders are at present being invited by the Municipal Authorities of Guadalajara for the concession for the electric lighting of the town during a period of 30 years.

Switzerland.—October 31st. Tenders are being invited until the 31st inst. by the Actien Gesellschaft Electricitätswerk an der Sihl, in Wädensweil, for the supply and erection of turbines of from 1,200 to 1,600 H.P., together with the necessary plant, for the central electric light and power station to be erected in Wädensweil.

Bury.—October 15th. The borough engineer has reported upon the tenders for the electric lighting plant and machinery, and an opportunity is now to be given to the whole of the persons originally tendering to submit fresh tenders for the continuous current plant already decided upon, and that the time for tendering be extended to October 15th.

CLOSED.

London, E.C.—Recently tenders were invited for the wiring of Moorgate Court. The contract consisted of 290 lights, and the wiring was a very complicated piece of work, and in the specification £75 and £5 had to be included for fixtures and cost of estimating. The tenders sent in were as follows:

Laing, Wharton & Down	£612
Vaughan Brown	555
B. Verity & Sons	478
Strode & Co.	349

This is a very remarkable instance of the disparity occurring in tenders for wiring contracts. The difference between the highest and lowest tenders, it will be observed, is £263, or only £86 less than the total for which Messrs. Strode offered to carry out the work. We have again to express ourselves as unable to understand what should cause the disparity, although our minds suggest several solutions.

Bedford.—The Town Council last week resolved to light the Town Hall and Corn Exchange by electricity. The following is a list of the tenders sent in:—

	£	s.	d.
Mr. H. Bacchus, Town Hall	113	1	0
Messrs. Kilpin & Billson, Town Hall	175	17	0
Mr. H. Bacchus, Town Hall Offices	13	17	0
Messrs. Kilpin & Billson, Town Hall Offices ...	24	15	6
Mr. H. Bacchus, Corn Exchange...	107	18	6
Messrs. Kilpin & Billson, Corn Exchange ...	116	14	0
Mr. H. Bacchus, basement	45	8	0
Messrs. Kilpin & Billson, basement	49	6	0

The scheme of Messrs. Kilpin & Billson for the Corn Exchange lighting, and that of Mr. Bacchus for the Town Hall and offices have been adopted, but both are subject to the approval of Mr. Medhurst, the engineer.

Edinburgh.—Messrs. Crompton & Co., Limited, have secured the order for the whole of the arc lamps for the Edinburgh streets.

Sheffield.—The tender of the Sheffield Electric Light and Power Company has been accepted for the supply of mains, cables, switches, &c. (not including fittings), for the lighting by electricity of the Weston Park Museum, for £174.

Southport.—The tender of the Fowler-Waring Cables Company has been accepted for the supply of 1,200 yards of high tension cable, for Scarisbrick New Road, at £57 per mile.

Lancaster.—For erecting a roof over the economiser at the central electric supply station, for the Town Council, the tender of Mr. W. Richardson for £43 has been accepted.

CITY NOTES.

Latimer Clark, Muirhead & Co.

The first meeting of creditors was held yesterday afternoon at Winchester House. The meeting was called by the receiver and liquidator (Mr. James Worley, F.C.A.) for the purpose of considering his report and statements showing position of affairs on January 18th, 1894, upon which date he was appointed on behalf of the debenture holders. Mr. Worley regrets that there does not appear to be any prospect of the unsecured creditors receiving a dividend. The recent sale of the undertaking by auction is not expected to realise more than £5,000. Mr. Worley states that his report was prepared in his capacity as receiver, and not as liquidator. The company was formed in October, 1883, when it acquired the business which had been carried on for several years by Mr. J. Latimer Clark and Mr. John Muirhead, at 23, Regency Street, Westminster, as also for the few previous years at Northumberland Works, Millwall, the freehold of which had been purchased by the vendors. This property, subject to mortgages for £22,800, with the sub-leases of the premises in Regency Street, and the plant and stock there and at Millwall, with the goodwill, were taken over at £79,520, afterwards reduced to £75,520, and payment for the same, less the mortgages, was made by the issue of 4,702 shares of £10 each, fully paid, and debentures for £5,700, being a portion of the first issue of £25,000. Sums amounting to £19,300 in all were received in cash at various times up to June, 1886, thus completing that issue.

The City of London Electric Lighting Company, Limited.—The revenue return of this Company for the quarter ended September 30th, 1894, is as follows:—Revenue from sale of current for public lighting, quarter ending September 30th, 1894, £3,141 19s. 2d.; corresponding quarter last year, £3,027 10s. 9d.; revenue from sale of current for private lighting, &c., quarter ended September 30th, 1894, £7,676 14s. 9d.; corresponding quarter last year, £3,551 15s.; estimated revenue from other sources, quarter ended September 30th, 1894, £416 12s. 5d.; corresponding quarter last year, £441 12s. 11d.; total, quarter ended September 30th, 1894, £11,235 6s. 4d.; corresponding quarter last year, £7,020 18s. 8d.; increase, £4,214 7s. 8d.; equivalent of 8 C.P. lamps connected on September 30th, 1894, 114,031; increase during quarter, 13,724; equivalent of 8 C.P. lamps connected on September 30th, 1893, 53,445; increase during corresponding quarter last year, 7,526.

Brazilian Submarine Telegraph Company, Limited.—The accounts of this company, subject to audit, show a profit sufficient to enable the directors to recommend a final dividend of 3s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ended June 30th, 1894, and also the payment of a bonus of 1s. per share, both free of income tax, which, together, will amount to £26,000, leaving a balance of £16,501, of which amount £15,000 has been placed to the reserve fund and £1,501 carried forward. For the purpose of paying the above dividend and bonus on the 25th inst., the Register of Transfers will be closed from the 16th to the 24th inst., both days inclusive.

R. C. Cutting, Douglas & Co., Limited.—A petition for the winding-up of the above company was, on September 24th, presented to the Court by Croggon & Co., Limited., of 16, Upper Thames Street, E.C., creditors of the company. The petition is directed to be heard before the Court sitting at the Royal Courts of Justice, Strand, London, on October 24th, 1894; and any creditor or contributory of the said company desirous to support or oppose the making of an order on the said petition, may appear at the time of hearing by himself, or his counsel, for that purpose.

Submarine Cables Trust.—On and after October 15th the sum of £1 15s. on account of the coupon due the same date will be paid by Messrs. Glyn, Mills & Co., of 67, Lombard Street, between the hours of 10 a.m. and 2 p.m. The coupons should be left with the bankers for examination four clear days before payment.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending October 7th, 1894, amounted to £892; week ending October 8th, 1893, £816; increase, £76; total receipts for half-year, 1894, £12,011; corresponding period, 1893, £11,295; increase, £716.

The Great Northern Telegraph Company. The traffic receipts in September 1894, were £25,200; January 1st to Septembr 30th, 1894, £207,400; corresponding months, 1893, £203,600; corresponding months, 1892, £199,600.

The Liverpool Overhead Railway Company. The traffic receipts for the week ending October 7th, 1894, amounted to £908; corresponding week last year, £666.

The Western and Brazilian Telegraph Company, **Limited. The receipts for the week ending** October 5th, after deducting **17 per cent. of** the gross **receipts payable to the London** Platino-**Brazilian Telegraph** Company, **Limited, were £5,186.**

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation October 3rd.	Closing Quotation, October 10th.	Business done during week ended October 10th, 1894. Highest.	Lowest
173,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	102 —105	102 —105	...	...
1,012,880*l*	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	39 — 42	39 — 42	...	...
2,993,560*l*	Do. do. 6 % Pref.	Stock	£5 5s.	£5 10s.	£5 2s.	75 — 76	75½ — 76½	76⅞	75¼
2,993,560*l*	Do. do. Defd.	Stock	...	...	...	6⅜ — 7¼	6⅜ — 7¼	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½% §	6½% §	12¾ — 13¼	12¾ — 13¼	13⅛	12⅞
75,000*l*	Do. do. 5 %, repayable June 1906	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	2 — 3	2 — 3	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	135 —145 xd	135 —145	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½% §	2 % §	2 % §	⅛ — ¼	⅛ — ¼	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½ — 13½	12½ — 13½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	4¼ — 4⅜xd	4¼ — 4⅜	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9¼ — 9⅞xd	9¼ — 9⅞	...	...
30,000*l*	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	...	105 —108%	105 —108%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	2⅝% §	8⅞ — 9¼	8⅞ — 9¼	9⅛	8⅞
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½% §	15⅞ — 16⅛	15¾ — 16	16	15⅞
70,000	Do. 6 % Pref.	10	6 % §	6 % §	6 % §	16¾ — 17¼	16¾ — 17¼	17	16¾
102,100*l*	Do. 5 % Debs., repay. August, 1899	100	...	...	...	106 —110	106 —110	...	...
1,297,837*l*	Do. 4 % Mort. Deb.	Stock	...	...	...	118 —121	118 —121	119½	119
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	16 — 16¼	16 — 16¼	16 3/16	15¾
54,100*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —106	103 —106	...	...
194,300*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	103 —106	103 —106	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	...	...	...	116 —120	116 —120	...	...
95,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —106	...	...
129,100*l*	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	103 —106	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	104 —107	104 —107	106	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	109 —112%	109 —112%	111	...
180,227	Globe Telegraph and Trust, Ltd.	10	5⅛% §	4⅜% §	4⅝% §	8⅞ — 9⅛	8⅞ — 9⅛	9⅛	8⅛
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15⅞ — 16⅛	15¾ — 16¼	16¼	15⅞
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜%	20½ — 21½	20½ — 21½	...	...
190,000*l*	Do. do. do. 5 % Debs.	100	...	...	...	103 —106	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	46 — 48	46 — 48	47⅜	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	5 — 7	5 — 7	...	...
100,000*l*	Do. do. 6 % Debs.	100	...	...	...	107 —110	107 —110	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	¼ — ⅜	¼ — ⅜	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 1½	1 — 1½	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	5 % §	4⅞ — 5⅛	4⅞ — 5⅛	5⅛	4⅞
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	15 — 15½	15 — 15½	15⅜	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14 — 15	14 — 15	14⅜	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5⅛ — 5⅜	5⅛ — 5⅜	5⅜	5 1/16
1,000,000*l*	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	109 —112	109 —112	110	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	7/16 — 9/16	7/16 — 9/16	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	104 —107	104 —107	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	0 %	3 — 5	3 — 5	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	106 —111	106 —111	109	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2 — 3	2 — 3	2⅛	...
146,733*l*	Do. do. 5 % Debs.	Stock	...	...	...	88 — 94	88 — 94	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	0 %	3 — 5	3 — 5	...	...
249,900*l*	Do. do. do. 5 % Debs.	100	...	...	...	100 —103	100 —103	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2 — 3	2 — 3	...	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	101 —106	101 —106	105	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	2½%	8¾ — 9¼	8¾ — 9¼	...	...
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	6¾ — 7¼	6½ — 7	...	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	2¾ — 3¼	2¾ — 3¼	2⅞	...
171,900*l*	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	106 —109	106 —109	...	...
214,800*l*	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	⅜%	1⅜ — 1⅝	1⅜ — 1⅝	1 7/16	1⅜
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10¾ — 11¼	10¾ — 11¼	11	10⅞
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	9 — 10	9 — 10	9¾	9 1/16
80,000*l*	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	108 —111	108 —111	110½	...
$1,211,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	115 —120	115 —120	...	...
166,900*l*	Do. do. 6 % Ster. Bonds.	100	...	...	...	102 —104	102 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4½ — 5½	4½ — 5½	5	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	...	13 — 14	13 — 14	13⅜	13½
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	...	6 %	6 %	14¾ — 15¼	14½ — 15	15⅛	14⅝
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	131 —133	131 —133	133½	132
50,000	†Liverpool Electric Supply, all paid	5	4½%	5 %	5 %	6¾ — 7	6¾ — 7	...	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	2½%	9¾ — 10¼	9½ — 10	10	9⅞
100,000*l*	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	... — ...	... — ...	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	5½ — 6½	5½ — 6¼	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7½%	4½%	7 — 7½	7¼ — 7⅜	7⅛	7
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8¼ — 9	8¼ — 9	8⅝	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	6¼ — 6⅝	6¾ — 7¼	7	6 1/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, Oct. 3rd.	Closing Quotation, Oct. 10th.	Business done during week ended Oct. 10th, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2¾ — 3	2¾ — 3	3	2 15/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2¼ — 2¾	2½ — 2¾	2 15/16	2 9/16
125,000/	Do. do. 4½ % Deb.	Stock	...	...	...	109 —112	110 —113	...	...
630,000/	City and South London Railway	Stock	...	8/8 %	8/8 %	36 — 38	36 — 38	37½	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	7 % §	2 — 2¼	2 — 2½	2¼	2⅛
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	94 — 99xd	94 — 99	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	½ — ⅝	3/8 — 5/8	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½ — 2 xd	1⅝ — 2¼	2⅛	2
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750 ...	2	*nil*	*nil*	*nil*	3/16 — 5/16	3/16 — 5/16	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1⅜ — 1⅝	1⅜ — 1⅝	1½	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	1½ — 1⅝	1½ — 1⅝	1 3/16	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½ — 1½	½ — 1½	...	...
9,600/	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½ — 7½	6½ — 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	5 %	8 — 8½	8 — 9	8¼	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	24 — 25	24 — 25	24 1/16	24 9/16
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	7⅞ — 8¼	7⅞ — 8¼	...	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	13 — 13¼	13 — 13¼	...	...
	Swan United Electric Light, Ltd.	...	11 % §	10 % §	7½% §	... — ...	... — ...	...	...
37,250	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	41 — 43	41 — 43	42	41⅜
150,000/	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	105—106	105 —108	107	106
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2 — 2¼	2 — 2¼	2 3/16	2⅛

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅜.
Electric Construction Corporation, 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1⅞—2¼.
House-to-House Company (£5 paid), 1—1½.
Do. do. 7 % Preference, of £5, 5¼—5½.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅞—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅜.
Liverpool Electric Supply, £5 (fully paid), 6⅜—6½.
Do. do. £3 10s. paid, 4½—4⅝.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

DUPLEX TELEPHONY.*

By T. R. ROSEBRUGH.

In considering this question, I propose to do so with reference only to the principles involved, the question of priority of invention of any of these being left untouched.

The name "duplex telephony," though not altogether exact as a description of the methods to which I intend to refer in this paper, is nevertheless very near to the meaning.

It will be as well to consider at the outset how the telephone problem differs from that of the telegraph, for one might naturally suppose that the known methods of duplexing telegraphic transmission would be available for the telephone. Actually there is little in common.

The electrical impulses which are used in telegraphy are of definite and predetermined character as to polarity and strength of current while they last, and differ only in their duration and grouping in time, while those of telephony are, of course, from the point of view of the electrician, entirely uncontrollable. Besides this in telegraphy, at the receiving end, the only information really given by the sounder is the interval during which its corresponding key at the transmitting end was raised or depressed, and this is sufficient; whereas at the receiving station the waves of telephone current must be received in very nearly their original form. This means then of increasing the working capacity of telephone lines is not available, while in ordinary practice in telegraphy the distinction between change of polarity and increase of current doubles the capacity of the line. In the second place, in any system of transmission, telegraphic or telephonic, it is possible so to arrange the circuit, that a receiving instrument is shielded from the effect of the transmitter at the same station, while responding to that at the distant end. This may be done in several ways, the "bridge" method being most usual. In this method the two wires which enter the station, or the wire and the earth conductor, are connected as though their resistance was to be measured in the usual way, the receiving instrument taking the place of the galvanometer, so that when properly balanced it only responds to the transmitter at the distant end. Three reasons prevent this method from being useful for telephonic purposes; a satisfactory balance would be more difficult to obtain, owing to the capacity and self-induction of the line, and self-induction in the instruments at the other end; besides this only a fraction of the current would be employed usefully; and probably more important than either of these is the fact that while the telegraph may be used for the continuous transmission of messages in one direction, the telephone is intended essentially for conversation, so that even if a pair of simultaneous transmissions in opposite directions over a line were established, a single conversation would demand the use of both.

The third difference consists in the well known fact that on account of the sensitiveness of the telephone the circuit in which it is placed must be as nearly neutral as possible to outside influences both electrostatic and electro-magnetic, as well as to the direct action of differences of earth potential; and this can only be done by a return metallic conductor traversing practically the same path as the first.

For these reasons, then, it happens that given a single metallic conductor extending between two distant points, with access to an earth connection at both points, used as a telegraph circuit in the ordinary way, four messages may be transmitted simultaneously, yet the same conductor will only suffice for a single conversation in a very unsatisfactory way.

Since two wires are necessary for the proper transmission of one message by telephone, it might hastily be assumed that this is a constant ratio, that is, that the conductors must always be twice as many as the number of messages that are to be transmitted simultaneously. The fact is, that it is the difference and not the ratio which is constant. There is no doubt, for example, that if it were necessary, ten messages could be transmitted simultaneously by eleven conductors without interference, although in that case it is exceedingly

* Read before the Canadian Electrical Association.

doubtful whether the complexity of the system would not preclude its use.

The most natural way of proceeding to increase the transmitting capacity of telephone conductors is to regard the already existing two-wire metallic circuits as the units out of which to construct metallic circuits of a higher order, which I will term derived circuits.

It is necessary, then, that two points be obtained on a two-wire metallic circuit, satisfying the condition, firstly, that no difference of potential be produced between them by the action of the transmitters already in that circuit, and, secondly, that no effect be produced in the receivers of the circuit by the entrance and exit of current at these two points. The first condition may be satisfied in two ways, according to the arrangement of the instruments already in circuit. If intermediate transmitting instruments are to be in series, they must be divided into two similar parts, one in each line, as in fig. 1 are D and E, two secondary coils of transmitter, T_1, arranged so as to contribute at each instant electromotive forces equal and in the same sense with regard to the metallic circuit, and therefore in opposite directions with regard to the line.

If the two sides of the metallic circuit have the same resistance, it will be seen that no difference of potential can be produced between the points where the two lines unite, as in fig. 1, at P_1, and the corresponding point at the other end

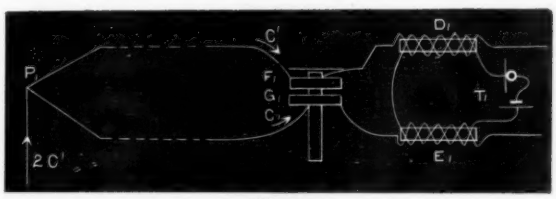


Fig. 1.

of the line. If, however, the transmitting instruments are only at the terminals or are bridged across between the two sides at intermediate stations, as in fig. 2, no such modification in their structure is necessary, for their action cannot produce any difference of potential between points which are at the middle of any bridges between the lines.

It is not true, as might at first be supposed, that every bridge has a middle point, for such a point must divide both the resistance of the bridge, and its inductance, if there be any, into two equal parts, and there will not in every case be such a point. In the case of a secondary of a repeating coil it will be necessary also that the two parts have equal mutual inductance with regard to the primary before the point between the two coils satisfies the condition of having the mean potential at every instant.

Since in any case the currents introduced on the lines of the two-wire metallic circuit must divide equally and flow parallel to one another in the same direction, we find the condition that the receiving instruments of the original metallic circuit should not be disturbed by such currents to be, either that the currents should not flow through the coils at all—which may be attained by bridging them between opposite points on the two lines, or, if the introduced current on one line flows through a coil of the receiving instrument, then that on the other line must flow through a coil in the opposite direction, which is just capable of neutralising the magnetic effect of the first. As for instance, in fig. 1, the introduced current, $2c'$, entering at P_1, divides into two parts C_1, which circulate in opposite directions through the coils, F_1 and G_1, of the receiver, and produce no effect, and similarly, also, in the coils, F_2 and G_2, on the same line. Supposing the bridge method selected as being applicable more generally, let us look at the different ways in which it may be carried out. In fig. 2, L_1 and L_2 are two lines which are supposed to be already in use as a metallic circuit, T_1 and S_1 being the transmitter and receiver at one end, and T_2 and S_2 at the other. L_3 and L_4 are similarly two lines of another metallic circuit. Between the points, A and B, are connected in series two equal non-inductive resistances, R. At their common point, P_1, a wire connects through telephonic apparatus, T_5 and S_5 with P_2, a similar wire on the same metallic circuit, including also at the second end the telephonic apparatus, T_6 and S_6; or it may connect with Q_1, which is a similar connection on the second metallic circuit, and similarly P_2 with Q_2, both connections including telephonic apparatus. Each of these bridges has then a resistance 2R, but owing to the line resistance it would generally be incorrect to say that they are equivalent to a single shunt of resistance, R. The current on the derived circuit passes through the coils of each pair of resistances in multiple, and each is therefore equivalent to $\frac{1}{2}$R. It is to be noted that currents arriving at A and B from P_1, on the derived circuit, do not divide at these points as might be supposed, but that portion of the circuit at the end between A and B, including T_1 and S_1, is left entirely dead, since, due to such currents, there is no difference of potential between A and B. The same thing applies also to T_2 and S_2, and to any other telephonic apparatus of this circuit bridged across between L_1 and L_2, which is not provided with an exit at its middle point.

As a first improvement on this construction, it may be suggested that a self-inductive resistance would be better than a purely ohmic resistance, if not connected exactly at the ends of the line, for it would partly compensate the effect of electrostatic capacity between the wires.

The next step in advance is to put the two coils R together on the same core, as in a telegraph relay, fig. 3, so that while

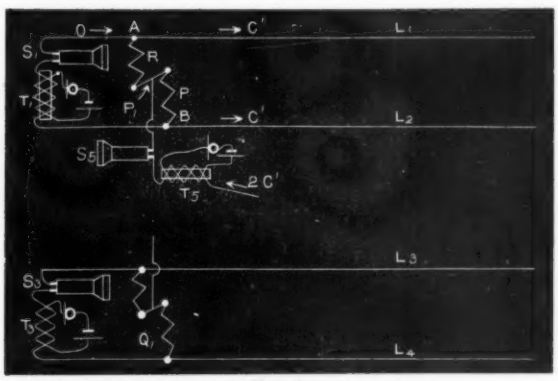
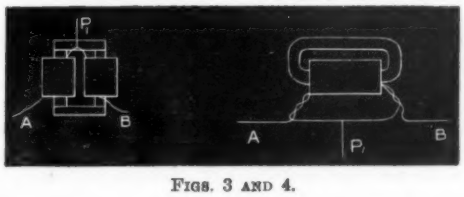


Fig. 2.

the leakage current passing from A to B through the two coils in the same direction around the core reinforces the magnetism of the core and experiences consequently a high impedance, that from the derived circuit which enters at P, the middle point, and divides there, passing in opposite directions around the core in the two coils, affects the magnetic circuit comparatively little, and has therefore low impedance. In the case of an ordinary box relay of 150 ohms, we would have in series from A to B a resistance of 150 ohms, and an inductance of 4·8 henry, while from P_1 to A and B in parallel we have 37½ ohms and ·49 henry, or to the note "middle C" an impedance of about 7,730 ohms to currents leaking through its coils in series, and 790 to the derived currents dividing from the middle point outwards, making a total impedance of 3,160 ohms in addition to the ohmic resistance of the derived circuit. Better results than this could be obtained by superimposing the windings instead of having



Figs. 3 and 4.

them on the separate limbs of the magnetic circuit. The best possible results, however, will be obtained when the derived current forking at P_1 to A and B traverses practically identical courses in opposite directions around the magnetic core, and has therefore a non-inductive path, while the leakage current from A to B passes over this course twice in the same direction, experiencing the maximum impedance. This may

be accomplished most exactly by twisting the wires together and winding the double conductor on the coil. A coil made in this way, fig. 4, measured 480 ohms and 4·6 henry to the leakage current, or an impedance of about 7,400 ohms to the note "middle C," while to the derived current entering at its middle point it was practically a non-inductive resistance of 120 ohms. In good modern construction it is necessary on circuits of moderate length to transpose the wires on the poles, in order to expose them equally to outside disturbing influences. In addition to this transposition, to get the best results it is often desirable to transpose the circuits among themselves; this transposition of the metallic circuits is more necessary when derived circuits are formed from them, for in that case transposition on the poles is as important as it is for single conductors, to which they are then equivalent. For this reason the derived circuit should not be applied to a pair of circuits differing materially in length.

The underground cable system connecting stations in the same city affords an excellent opportunity for the application of the above principles, for a large number of metallic circuits between the same two points are in continual demand and are expensive. A redistribution of the positions of the wires in the cable being made at every manhole, the transposition must be quite thorough.

Coils such as are indicated in fig. 4 have been in use in Toronto for some time on the cable between the main office and the Yorkville station; they afford an extra speaking circuit for each pair to which they are applied, in which as well as in the two original circuits, speech is perfectly transmitted. The same thing is true of a pair of metallic circuits between Toronto and Hamilton, when the circuits are free from long extensions.

It appears quite probable that on very long lines the decreased conductor resistance and self-induction of the derived circuit as compared with the originals would fully counterbalance the increased electrostatic capacity, and give, for example, between New York and Chicago, three speaking circuits for every four conductors, instead of two, the transmission being unimpaired in any of the circuits.

ON PERSISTENT ELECTRIC OSCILLATIONS AND THEIR EFFECTS.*

By H. EBERT.

In recent times investigators have applied themselves with ever increasing interest to the problem of producing light by electric oscillations or alternate currents of high frequency, such as are obtained by condenser discharges. Only in a few isolated cases, however, have the arrangements fulfilled the necessary conditions for obtaining the maximum lighting effect from the given supply of energy. Furthermore, as far as known to the author, there have been no measurements made of the economy of lighting effected in this way. However brilliant the luminous effects obtained by Tesla may have been, it is only by measurements of the total energy expended to produce the lighting effect that we can hope to arrive at a conclusion as to whether an economical advance in the art of lighting is to be expected from this system. The author wishes to show that by observing the necessary conditions, considerable light effects can be obtained by very simple means from very long continued electrical movements of the kind just mentioned.

The conditions necessary for obtaining the maximum luminous effects by the influence of electric oscillations on rarefied gases, have been investigated by E. Wiedemann and the author by means of Lecher's parallel wire arrangement. In all cases the result was obtained, that the best effects could only be attained when the secondary circuit was exactly "tuned" to the primary discharging circuit. The oscillations in the secondary circuit must in fact be what is called, in the theory of sound, resonant. It was found also that perfectly regular oscillations could be obtained only when air condensers were employed. When the Leyden jar, or any other condenser with solid dielectric was used, disturbances and irregularities were introduced by the well known residual actions that occur in these cases.

These, and similar experiments, showed that to obtain luminous effects in a rational manner by means of electric oscillations or high frequency currents, we must—

Firstly.—Time the primary and secondary circuits exactly to one another. That is to say, the time of oscillation $T = 2\pi\sqrt{L\,C}$ must be the same, or in a simple harmonic relation for both circuits.

Secondly.—The capacity of the air or oil condensers in the circuits must be as small as possible, in order to reduce the damping to a minimum. The logarithmic decrement of the electric oscillations is given by the expression $\pi R\sqrt{C/L}$ (R, the ohmic resistance; C, the capacity; and L, the self-induction of the circuit). It appears from this expression that, as stated, C must be as small as possible, and L as large as possible for a given R; but the limit of increase of L is soon reached.

It is not necessary to use high tensions, since it has been found that intense light effects can be produced by the movement of exceedingly small quantities of electricity, provided only that the oscillations follow each other regularly and are persistent.

Keeping these considerations in view, a simple apparatus has been designed which has proved very effective for producing electric light by high frequency currents. The principle of the apparatus can be readily seen from the diagram (fig. 1). The current (from an influence machine, an induction coil, or a sufficiently highly transformed alternating current) coming in by the conductors, Q, charges the two condenser plates, N_2 and N_3, which, thereupon, induce upon the plates, N_1 and N_4, corresponding charges. When a spark passes at G, the charges heaped up on N_1 and N_4 equalise themselves, with oscillations, through the coil, S. Round this coil, S, is wound a similar coil connected to the plates, N_5 N_6, of the secondary condenser. Between these two plates is developed the high frequency field. Vacuum tubes or other objects to be acted upon may be introduced between the plates, N_5 and N_6, or they may be metallically connected to them by wires. There is thus no direct metallic connection between the primary and secondary circuits, but they mutually act upon one another by the lateral induction of the spirals. By changing the distance between the condenser plates, the two circuits can be tuned into exact unison with one another. By changing the capacity, by applying longer or shorter spirals, S, or by increasing or diminishing the length of the primary spark gap, or the number of the sparks, the conditions of the experiment can be indefinitely varied, and more especially the frequency of the oscillations can be varied within wide limits.

Fig. 1.

The condensers are simply made of couples of metal plates mounted so as to slide on glass rods passing through their centres. There is no danger of leakage along the glass rod, as the spark gap is only 2 to 3 mm. in length. It is found to be much better to use many small sparks, provided they are regular and sharp, than long sparks.

* *Wied. Ann.*, Vol. liii., p. 144.

With this apparatus, 20,000 oscillations will take place before the amplitude is damped down to the 2·7th part of the original value. If the number of sparks at G is sufficiently increased (and this can be done without a large supply of electricity on account of their shortness), the field between N_5 and N_6 may be kept in an almost uninterrupted state of oscillation.

Since everything in the wave apparatus is so adjusted that the activity of the oscillations is a maximum, only a very small exciter is necessary. Even a single plate influence machine serves to excite it, though, of course, the phenomena with a multiple plate machine are much more brilliant. A medium sized induction coil gives very fair luminous effects, but generally it is not so suitable as the influence machine, because the supply of electricity is not usually sufficiently regular.

The application of this resonant wave apparatus to the excitation of vacuum tubes, and spectroscopic investigations at low temperatures is described, but we give here only its application to the production of light. Wiedemann and the author had shown in previous investigations that regular, weakly damped, electrical oscillations possessed a very remarkable power of exciting cathode rays of great intensity, which have a remarkably great capacity of producing fluorescence or phosphorescence, or to speak generally, luminescence, with very small expenditure of energy.

Even with very small sparks and amounts of energy on the secondary condenser, these cathode effects attain, when everything is properly tuned, an intensity which is quite comparable with that obtained by using large alternating generators. If a suitable phosphorescent substance is exposed to these rays, it will emit a considerable amount of light. Even when powerful alternating currents are employed to excite the phosphorescence, scarcely any heat is produced. A lamp is thus obtained which emits almost only visible rays, without development of heat, and consequently the amount of energy which the lamp consumes is enormously small.

A simple, but very economical "luminescent lamp" may be constructed by fusing the glass tube, B, fig. 2, in the glass bulb, A, closing it at the lower end, and fixing a disc, C, of compressed luminous paint (Leuchtfarbe) by a wire at the top. The bulb is then exhausted by the tube, D, and closed. Two strips of tinfoil, E_1 and E_2, are glued on, and furnished with hooks, H_1, H_2, to which the condenser plates, N_5, N_6, of the wave apparatus are connnected. When the electric oscillations act upon the coatings, E_1, E_2, active cathode rays are formed on the inner surface and perpendicular to it. These rays, though almost invisible themselves, produce a strong luminescent light upon the surface of the luminous paint on which they converge, and the light radiates out through the transparent ends, K_1, K_2, of the bulb.

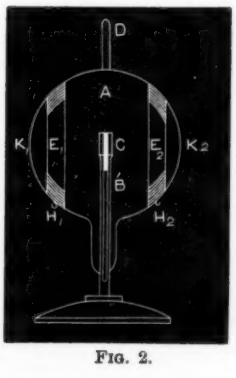


Fig. 2.

A series of preliminary experiments were made to determine the efficiency of the "luminescent lamp." The candle-power was found to be about one-thirtieth to one-fortieth of the amyl acetate standard, which is approximately equal to the standard candle in this country. The energy expended being difficult to measure directly, was calculated from the capacity and potential of the secondary circuit. It was found that the energy actually expended in producing the light was about one-millionth part of a watt. By comparing the brightness of this lamp in the visible part with that of the amyl acetate lamp, and calculating for both the *total* energy consumed in their maintenance, it was found that the high frequency lamp consumed from 1,500 to 2,000 times less energy than the amyl acetate standard.

One difficulty in the way of the practical application of the high frequency lamp is that the high frequency currents could not be carried to great distance even in a straight cable, on account of the resistance which self-induction would oppose to such rapid oscillations; but the difficulty may to a certain extent be overcome by effecting the transformation to high frequency at the lamps. Since only condensers of small capacity, and small inductances are required, a simple and very compendious apparatus of the kind described could be combined with the lamp.

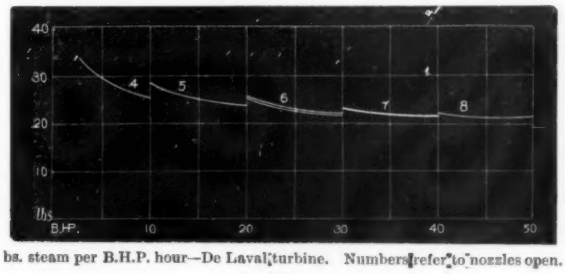
The economy of all arrangements which were not perfectly tuned as above explained was found to be much less.

NOTES ON THE STEAM TURBINE.

By KENELM EDGCUMBE.

(*Continued from page* 397.)

The power to be transmitted may be roughly estimated as follows:—The wheel of a 60 H.P. motor is 1 foot in diameter, and, therefore, at its speed of 18,000 revolutions the velocity of the blades at the periphery is 940 feet per second. Hence the total power to be transmitted is $\frac{33{,}000}{940} = 35$ lbs. This is further divided up among eight nozzles, making only 4·4 lbs. to be transmitted by each blade. Hence it is evident that the whole wheel can be made extremely small and light. It was found very difficult, however, to ensure the accurate balancing of the wheel, and as, at so high a speed, this is a matter of great importance, the plan was adopted of making the shaft somewhat flexible. By this means, even should the adjusting be inexact, the wheel will revolve round its true axial centre of gravity, and thus all vibration is prevented. One other point which deserves special notice is the fact that the jets, situated four on either side of the wheel, can be closed one by one as the load is increased, thus keeping the initial pressure nearly constant, while the total pressure exerted on the shaft is varied according to the load. By this method all throttling is avoided, the governor merely making the final adjustment of the speed. The great economy in steam consumption, accomplished by this means, will be seen from the curve (fig. 3) taken at a trial recently carried out for the author, in order to determine this point. It will be seen from the diagram that the steam consumption at three-quarters load is only ½ lb. more, and at half-load 2 lbs. more, than at full load. Although this turbine has been applied to every description of work, it is more generally used in connection with a dynamo. The latter has a ring-wound armature, and magnets of the Manchester type. In the larger machines (above 15 H.P.) the dynamo has two armatures between the same pole pieces, in order to balance the gearing, which is also double. Each gives 110 volts, and they can be run in series or parallel. In consequence of the smooth running of these motors, all heavy foundations are entirely dispensed with. A wooden frame, resting on India-



lbs. steam per B.H.P. hour—De Laval turbine. Numbers refer to nozzles open.

Fig. 3.

rubber, is all the foundation needed for the smaller machines. For those above 30 H.P. a light brick base is usually employed. The outside measurements of a 50 H.P. set are, height 4 feet 11 inches, extreme length 7 feet 4 inches, width 5 feet 5 inches. The weight, complete, is under 70 cwt., that of the engine alone being 30 cwt. In a trial carried out last year by Prof. Cederblom, of Stockholm, and two other experts, a nominal 50 H.P. steam turbine was tested, with steam at 130 lbs. (abs.) and a vacuum of 26½ inches. The output was 63·7 B.H.P., and the steam consumption at full load was 19¾ lbs. per B.H.P. hour, or 20¼ lbs. at three-quarters load, and 21¾ lbs. at half load. Considering the comparatively small size of the motor, it is needless to remark on the excellence of these results.

The turbo-generator of Mr. Parsons is so well known as to require but a very brief description. The earlier motors were of the parallel flow type, and consisted of two turbines of the Jonval model mounted on the same shaft. This arrangement later gave way to the outward flow type, as used now. A 150-unit motor tested by Prof. Kennedy consisted of six parallel discs of 15 inches in diameter, carrying outward flow blades, through which the steam flows in series before entering a larger double wheel 26¾ inches in diameter, through the two sides of which it flows in parallel. The size of the apertures and blades is adapted to the increasing volume of the steam, as it expands from 120 lbs. to below 1 lb. In order to overcome any tendency of the shaft to vibrate, and so heat the bearings, the latter are of special construction. The shaft revolves in a phosphor bronze sleeve within three concentric steel tubes, which fit loosely within each other, the whole being immersed in oil, which forms a thin film between the tubes. By this arrangement the shaft is allowed the necessary amount of play, while any tendency to vibration is damped by the viscosity of the enclosed oil. The one-sided action of the first six discs is balanced by a revolving baffle piston at the high-pressure end, besides which there is an adjustable grooved thrust bearing, which not only allows for any wear being taken up, but also admits of the amount of clearance over the tips of the blades being regulated. The speed is kept constant at 4,500 revs. per minute by a very sensitive form of governor. A double beat lift valve in the admission steam pipe is caused to close every 28 revs., or about 150 times per minute, the time during which steam is thus cut off is regulated by a solenoid compounded so as to maintain the volts constant. It was found that at half load the pressure fell each time the valve closed below that of the atmosphere, while at full load the steam was admitted in an almost continuous blast. The pressure on the under side of the governor was found to be some 4 lbs. below that in the steam pipe. This motor seems only to have been used in connection with an electric generator, and that chiefly on the alternate system, but it has been found to give equally good results with a direct current dynamo, and, in fact, most of Prof. Ewing's trials were made with a 200-volt continuous current generator. The chief obstacle in the way of coupling alternators direct has hitherto been the difficulty of obtaining the requisite periodicity, at a low speed, without the use of a large and heavy machine. With the turbine, however, owing to its high speed, this objection has been entirely removed. In a 150-unit set employed at Portsmouth central station, and designed for 160 lbs. steam pressure, the alternator, which is a two-pole machine with inwards pointing poles, supplies a current of 75 ampères at 2,000 volts. Since the periodicity adopted at Portsmouth is only 50 ~ per second, the speed has to be kept at 3,000 revolutions per minute. An alternator, supplied to the engineering laboratory at Cambridge for experimental purposes, has 140 poles, and hence, at 1,200 revolutions the periodicity reaches 1,400 ~ per second, yielding 5 ampères and 100 volts. In both these sets the exciter is on the same shaft as the alternator. It does not appear that any tests have been made as to the parallel running of these generators, but with such a high light-load efficiency as they possess, it is, perhaps, hardly necessary.

In December, 1891, Prof. Ewing found for a 100-unit set of similar form to the one described, but having fewer blades and an inferior governor, a steam consumption of 37 lbs. per kilowatt at full load, 39 lbs. at ½ load, and 43 lbs. at ¼ load. In August, 1892, Prof. Ewing again carried out an extensive series of trials of the same turbine, but with the improvements we have already described. The chief feature was, however, the use of superheated steam. With steam superheated to 400° and again to 465°, the following results were obtained :—

		465°.	400°.
Lbs. steam per unit	Full load	27 lbs.	28½ lbs.
	¾ „	27½ „	29 „
	½ „	29¼ „	32 „

The great improvement here noticeable over the 1891 trials must to a great extent be ascribed to the superheating, though no experiments were made to determine the effect of the other improvements on the economy. In March, last year, Prof. Kennedy tested a motor similar to the last, but designed for an output of 150 units. It was, however, not possible to test the steam consumption at more than ⅔ths load, owing to the smallness of the boiler employed. The results obtained, however, indicate a consumption of 26½ lbs. per unit at full load, 28 lbs. at ¾ load, and 31 at ½ load. The pressure was 115 lbs. (abs.), and the back pressure 1 lb., superheating being carried to 400°, as before.

(To be continued.)

REVIEWS.

Electric Lighting Plants: Their Cost and Operation. By W. J. Buckley. Chicago: Wm. Johnston & Co.

It is quite refreshing to come across a really interesting work on electric light plants, even although it should be confined mostly to the plant made by a single company. As a rule books on electric light plants consist of bald descriptions and poor illustrations of a most aggravatingly superficial character; this one deals with the subject from the investor's and buyer's point of view, and minutely and intelligently goes into the details of first cost and maintenance and efficiencies.

It contains a great store of valuable information which, although it relates entirely to American practice, will be valuable to engineers on this side.

It has a few capital wiring tables and some good illustrations which have the unusual merit of being original; it does not confine itself to the electrical portion of the plant but goes into the question of fuel, oils, boilers, engines, driving gear, buildings, &c.

A Practical Treatise on Patents, Trade Marks and Designs, with a Digest of Foreign and Colonial Laws. By David Fulton, A.M.I.C.E. London: Jordan & Sons.

A most complete and valuable work of reference for the patent agent, the patentee, the manufacturer, or investor in patents. Copious references are made to cases which have been decided in patent law and their bearing fully discussed.

The procedure under the various laws governing patents, trade marks, &c., is very clearly explained.

The whole of the subjects are completely elucidated, and the work should form a standard one on all questions relating to patents, trade marks and designs, both here and abroad.

Electrical Engineering Leaflets. By Prof. E. J. Houston, Ph.D., and A. E. Kennelly, F.R.A.S. *Electrical Engineer*, New York.

These are little pamphlets of four leaves each; each leaflet deals with a definite subject, and an elementary and intermediate and advanced leaflet is issued on each subject, such as "resistance," E.M.F., "current," "induction," and so on, the series forming together a concise text-book of the up-to-date science of electrical engineering.

We can recommend this series to students and others engaged in the acquirement of a knowledge of the subjects, but such unused terms as resistivity, conductance, permittance, and so forth, might very well be dispensed with in electrical engineering works, although it may be the thing to introduce the new names for units such as hens, webers, oersteds, and gilberts, for self-induction, magnetic flux, magnetic resistance or *reluctance*, and ampère-turns or magneto-

motive force, a gilbert being ampère-turns × 1·257. It seems a pity that the simple and easily ascertained quantity—ampère-turns—could not be retained instead of the artificial gilbert; indeed, the ampère-turn is so much used in practice that it is doubtful if the gilbert will be substituted for it in computations. Magnets are built to feet and inches dimensions, as a rule, in America and on this side, so that the centimetre and metric system used is a little awkward, and entails continual reduction on the part of the practical student.

Thermo-dynamics of Reversible Cycles in Gases and Saturated Vapours. Full synopsis of a ten weeks' undergraduate course of lectures delivered by M. J. Pupin, Ph.D. Arranged and edited by Max Osterberg. New York: John Wiley & Sons.

The science of thermo-dynamics is little understood by engineers, and has had little influence on the progress of the heat engine. This is chiefly due, we think, in the first place to the fact that the treatment of this subject has usually been too abstruse to be easily mastered by anyone who was not an expert mathematician, and, in the second place, because the attainment of a cycle that will give the highest theoretical efficiency has been of far less importance than other considerations, in the practical construction of the steam engine. The great development of the gas and oil engines may, however, make the applications of the principles of thermo-dynamics of more importance than they have been with the steam engine, and every caloric engineer ought to understand the principles of this beautiful science.

This little treatise expounds the science of thermo-dynamics in its application to reversible cycles in gases and saturated vapours, on the lines of Clausius's great work, and in a style requiring the minimum of mathematical knowledge. The application of the first law to gases and then to saturated vapours is first discussed; then Carnot's cycle is explained, the equations of the second law deduced and applied first to perfect gases and then to saturated vapours. It is clearly demonstrated how and why the most perfect steam engine that can be made, falls short of the theoretically perfect steam engine. The methods adopted are algebraical throughout; little use being made of graphical methods. The temperature entrophy diagram is conspicuously absent. Considering the important applications that have recently been made of this diagram this is to be regretted. We feel sure if a graphical exposition of this science was written more from the temperature entrophy than the pressure volume point of view, that many of the knotty points in thermo-dynamics would be simplified and a much wider knowledge of the subject disseminated.

We would heartily recommend the study of this little work to anyone interested in thermo-dynamics, more especially as it presents the subject in a somewhat different, and we think, clearer, manner than is usual in English text books.

THE FATAL ACCIDENT AT BANKSIDE.

Last Friday, Mr. A. W. Wyatt, Deputy Coroner, held an inquest at the Grove Mission Hall, Southwark, on the body of Henry Hearne, aged 29 years, a fitter's labourer, in the employ of the Brush Electric Light Company. The body having been identified, John Gales, a fitter in the same employ, was called, and said that deceased had worked under him about two months. About four o'clock on Sunday afternoon, September 29th, witness noticed that the machinery worked stiffly, and ascended to the top of the switch pillar of one of the alternators to see where the mistake was, and left deceased standing at the foot of the ladder. About 20 minutes afterwards witness heard a scream, and upon looking round saw deceased lying on the ground at the foot of the next pillar with the ladder lying beside him. Witness jumped down and went to his assistance. Finding him unconscious, the manager and a doctor were at once sent for. The switch pillar that witness was attending to was not in use, consequently was "dead." Witness could not say why deceased attempted to climb on to the next pillar, which was "alive." He did not see deceased take the ladder away. He did not send deceased to No. 6 pillar for anything. Deceased should have remained at the bottom of the ladder till witness had finished the job. Deceased had been cautioned by the witness and the manager on several occasions not to touch anything without receiving instructions.

The Coroner: Do you think he got tired of holding the bottom of the ladder, and climbed on to the live pillar out of curiosity?

Witness: I cannot say. I know of no reason why he should go there. Witness had never known deceased to leave his work before. The distance between the pillars was about 19 feet.

A Juryman: Can you suggest the cause of deceased falling?

Witness: The ladder might have slipped while deceased was ascending it, and clutching one of the rods to save himself, received the shock.

Arthur Henry Foster, practical engineer to the company, said that he was in his office last Sunday afternoon, and noticed the lights suddenly flicker. Upon going to the pioneer station to ascertain the cause, he was informed of the occurrence. He saw the deceased being supported by two men. Artificial respiration was resorted to, but without success. The machine in question was sufficiently powerful to kill a man. The flickering was very noticeable, and occurred three times in succession. The switches on the top of the pillars were always "alive," unless under repair. Witness was totally at a loss to account for the accident.

Dr. J. G. Garbett, of 49, Sumner Street, Southwark, stated that upon his arrival life was extinct. Witness had subsequently made a *post mortem* examination of the body, and found the heart contracted. There were several marks on the outside of the right arm, with corresponding holes in the shirt sleeve, and the skin was stained red. The cause of death was stoppage of the heart's action, consequent upon electric shock.

The Jury returned a verdict accordingly.

ELECTRICAL STANDARDS.

The supplementary and final reports of the Electrical Standards Committee have been published. In our issue for August 31st, page 235, will be found the details given in this document, with the exception of the final report, from which the following is an extract:—

"To the Right Honourable James Bryce, M.P., President of the Board of Trade.

"Since the date of our last report, the Board of Trade have laid before us a *résume* of the action of the International Electrical Congress held in Chicago in August, 1893, to determine the units of electrical measurement. We were also informed by the Board of Trade that Her Majesty's Government had been invited by the United States ambassador in London to take steps to adopt the recommendations of the Congress.

"These recommendations, so far as they refer to the units of electrical resistance, electrical current, and electrical pressure, are substantially the same as those suggested for adoption in our previous reports.

"We see no reason for further delay in the legalisation of standards of the above-mentioned units, and we have prepared and attach a revised draft order in Council, which we advise may be submitted for Her Majesty's gracious approval.

"The accompanying notes to the specification for the Clark's cell have been communicated by Mr. Glazebrook, and will be found of great assistance in the preparation of this form of cell.

"(Signed) Courtenay Boyle, Kelvin, Francis J. S. Hopwood, P. Cardew, W. H. Preece, Rayleigh, G. Carey Foster, R. T. Glazebrook, J. Hopkinson, W. E. Ayrton.

"(Signed) T. W. P. Blomefield, *Secretary*.

"*August 2nd*, 1894.

"Notes to the Specification on the Preparation of the Clark Cell.

"*The Mercurous Sulphate.*—The treatment of the mercurous sulphate has for its object the removal of any mercuric sulphate which is often present as an impurity.

"Mercuric sulphate decomposes in the presence of water into an acid and a basic sulphate. The latter is a yellow substance—turpeth mineral—practically insoluble in water; its presence at any rate in moderate quantities has no effect on the cell. If, however, it is formed, the acid sulphate is formed also. This is soluble in water, and the acid produced affects the electromotive force. The object of the washings is to dissolve and remove this acid sulphate, and for this purpose the three washings described in the specification will in nearly all cases suffice. If, however, a great deal of the turpeth mineral is formed, it shows that there is a great deal of the acid sulphate present, and it will then be wiser to obtain a fresh sample of mercurous sulphate rather than to try by repeated washings to get rid of all the acid.

"The free mercury helps in the process of removing the acid, for the acid mercuric sulphate attacks it, forming mercurous sulphate and acid which is washed away.

"Pure mercurous sulphate when quite free from acid shows on repeated washing a faint primrose tinge, which is due to the formation of a basic mercurous salt, and is distinct from the turpeth mineral or basic mercuric sulphate. The appearance of this primrose tint may be taken as an indication of the fact that all the acid has been removed, and the washing may with advantage be continued until this primrose tint appears. Should large quantities of this basic mercurous salt be formed, the sulphate should be treated as described in the instructions for setting up Clark's cells, issued from the Physical Technical Institute of Berlin, *Zeitschrift für Instrumentenkunde*, 1893, Heft 5.

"*The Zinc Sulphate Solution.*—The object to be attained is the preparation of a neutral solution of pure zinc sulphate saturated with $Zn\,SO_4\,7H_2\,O$.

"At temperatures above 30° C. the zinc sulphate may crystallise out in another form; to avoid this, 30° C. should be the upper limit of temperature. At this temperature water will dissolve about 1·9 times its weight of the crystals. If any of the crystals put in remain undissolved, they will be removed by the filtration.

"The zinc sulphate should be free from iron, and should be tested before use with sulphocyanide of potassium to ascertain that this condition is satisfied. If an appreciable amount of iron is present, it should be removed by the method given in the directions already quoted, *Zeitschrift für Instrumentenkunde*, 1893, Heft 5.

"The amount of zinc oxide required depends on the acidity of the solution, but 2 per cent. will, in all cases which will arise in practice with reasonably good zinc sulphate, be ample. Another rule would be to add the zinc oxide gradually until the solution became slightly milky. The solution, when put into the cell, should not contain any free zinc oxide; if it does, then, when mixed with the mercurous sulphate, zinc sulphate and mercurous oxide are formed; the latter may be deposited on the zinc and affect the electromotive force of the cell. The difficulty is avoided by adding as described about 12 per cent. of mercurous sulphate before filtration; this is more than sufficient to combine with the whole of the zinc oxide originally put in, if it all remains free; the mercurous oxide formed, together with any undissolved mercurous sulphate, is removed by the filtration.

"*The Mercurous Sulphate and Zinc Sulphate Paste.*—Although, after the last washing of the mercurous sulphate, as much water as possible may have been drained off, sufficient water generally remains to necessitate the addition of a *very considerable* quantity of crystals of zinc sulphate from the stock bottle, in order to insure saturation, when the washed mercurous sulphate is added to the zinc sulphate solution as described in No. 4 of Specification B appended to the Order in Council.

"If the sides of the test tube above the cork be soiled by the introduction of the paste, the marine glue does not adhere to the glass; the liquid in the cell rises by capillary action between the glue and the glass, and may damage the cell.

"The form of the vessel containing the cell may be varied. In the H form devised by Lord Rayleigh, and modified by Dr. Kahle, the zinc is replaced by an amalgam of zinc and mercury. The other materials should be prepared as already described. Contact is made with the amalgam in one leg of the cell and with the mercury in the other by means of platinum wires sealed through the glass.

"The amalgam consists of about 90 parts of pure mercury mixed with 10 parts of pure redistilled zinc. These are heated in a porcelain crucible to about 100° C., and gently stirred until the zinc is completely dissolved in the mercury. The amalgam is liquid while warm, and must be poured into the cell before it becomes solid on cooling.

"The vessel containing the element consists of two vertical tubes. These, as shown in the figure, are closed below and open above into a

common neck, which can be closed by a ground stopper of glass. The two tubes should be 2 cm. in diameter, and 3 cm. in length. The neck should be at least 1·5 cm. in diameter, and 2 cm. long. A short length of platinum wire is sealed through the bottom of each tube.

"The end of the wire in one tube is covered by a small quantity of pure mercury, that in the other tube by the zinc-mercury amalgam.

"Above the mercury a layer about 1 cm. thick of the mercurous sulphate paste is placed; above this, and also above the amalgam, a layer also about 1 cm. in thickness of zinc-sulphate crystals, and the vessel is filled up with the saturated zinc-sulphate solution.

"The zinc sulphate crystals are obtained by evaporating at a temperature of less than 30° C. some of the zinc sulphate solution prepared as in 4 of the specification.

"The stopper is then inserted, leaving a small air bubble above the liquid, and sealed on the outside with shellac dissolved in alcohol.

"The ends of the platinum wires outside the cell form the two poles, and should be connected to suitable terminals."

NEW PATENTS—1894.

18,128. "Improvements in electrically controlled apparatus for checking and registering the attendance of workmen and the like." F. G. M. Wetherfield. (Communicated by C. K. Jardine, British Guiana.) Dated September 24th.

18,153. "Improvements in electricity meters." J. Perry. Dated September 25th.

18,172. "Improvements in and apparatus for the extraction of gold by electrolysis." J. J. MacLean. Dated September 25th.

18,177. "Improvements in electrically actuated brakes and belt-shifting devices." P. Auguste-Godchaux. Dated September 25th.

18,188. "Improvements in and relating to electrical fittings." E. Hungerbuhler and The Electrical Company, Limited. Dated September 25th.

18,196. "Improvements in current collectors for overhead electrical conductors." Siemens Bros. & Co., Limited. (Communicated by Siemens & Halske, Germany.) Dated September 25th.

18,202. "Improvements in and connected with primary batteries." H. V. Coad. Dated September 25th.

18,206. "Improvements in utilising residual products obtained in working certain kinds of voltaic batteries." W. Walker, jun., and F. R. Wilkins. Dated September 25th.

18,217. "Improvements relating to the transmission of telephonic messages between the shore and a lighthouse, ship, or other signal station." L. I. Blake. Dated September 25th. (*Complete.*)

18,273. "Improvements in electric motors." J. Imbay. (Communicated by La Société Anonyme pour la transmission de la force par L'electricité, France.) Dated September 26th.

18,274. "An improvement in electric arc lamps." J. Brockie. Dated September 26th.

18,288. "Improvements in secondary or storage batteries." C. Riordon. Dated September 26th. (*Complete.*)

18,289. "Improvements in electric motors." J. H. K. McCollum. Dated September 26th.

18,297. "Improved electric apparatus for striking bells and the like." D. Mathieu. Dated September 27th. (*Complete.*)

18,328. "An improved method of duplex telegraphy." G. E. Fletcher. Dated September 27th.

18,339. "Improvements in and connected with carbons for electric lamps or for other purposes." E. G. Acheson. Dated September 27th. (*Complete.*)

18,359. "Improvements in or connected with electrical elevating mechanism." B. Willcox. (Communicated by the Eisenwerk, late Nagel & Kaemp, Actien Gesellschaft, Germany.) Dated September 27th.

18,427. "Improvements in electrical traction and apparatus therefor." M. Hutin and M. Leblanc. Dated September 28th. (*Complete.*)

18,480. "Improvements in automatic electrical gas-lighters." W. N. Jaskey and E. S. Else. Dated September 29th. (*Complete.*)

18,501. "Improvements in or relating to incandescent electric lamps." W. T. Kerr. Dated September 29th.

18,507. "A quick break electric lampholder." C. O. Duetschmann. Dated September 29th.

18,522. "Improvements in electric arc lamps." W. S. Pendleton. Dated September 29th. (*Complete.*) [Date applied for under Patents, &c., Act, 1883, Section 103, March 6th, 1894, being date of application in United States.]

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

13,406. "Improvements in or relating to the treatment of sodium chloride, and to the method of utilising the products in the manufacture of white lead, and of soda, chlorine, and their derivatives." R. Haddan. (A communication from abroad by Compagnie Electrochimique de St. Béron.) Dated July 10th. The object of this invention is to utilise the chlorine and the sodium contained in chloride of sodium without any waste, and consequently cheaply. 7 claims.

13,533. "Safety insulated clip for extracting and replacing electric fuses." C. D'Oyley Hutchins. Dated July 12th. A clip composed of two semi-circular clasps continued to an insulated handle by a spring. The mouth of the clip when open is put round and securely fastened to the electric fuses intended to be extracted or replaced between generator and mains going to circuits with their branches. 1 claim.

14,130 "Improvements in the electrolysis of iodides, bromides, nitrates, and other salts." J. Hargreaves and T. Bird. Dated July 21st. Consists in the employment of apparatus of the kind described in Specification No. 18,871 of 1892, for use in the manufacture of alkali. 3 claims.

14,131. "Improvements in the electrolysis of chlorides, iodides, bromides, nitrates, and other salts, and in apparatus therefor." J. Hargreaves and T. Bird. Dated July 21st. Relates to the electrolysis of chlorides, iodides, bromides, nitrates and other salts, especially when apparatus described in Patent No. 18,871 of 1892, No. 5,197 of 1893, and No. 5,198 of 1893 is employed. Relates also to a modified method of forming the porous diaphragm applicable for use in electrolytic apparatus. 7 claims.

14,558. "Improvements in engines operated by the explosion of mixtures of combustible vapour, or gas and air." W. Hornsby and R. Edwards. Dated July 28th. Relates to improvements in explosion engines of that kind in which a chamber is attached to the working cylinder for the purpose of receiving the explosive charges of oil or other combustible vapour and air. 3 claims.

15,485. "Improvements in glow lamps and holders." E. Mann and J. Hopwood. Dated August 15th. Consists in constructing the lamp with two filaments and three lamp terminals. 3 claims.

23,170. "Improvements in electrical transformers." L. B. Miller and M. W. Woods. Dated December 2nd. Consists in winding the secondary circuit of a ring or other transformer with bare wire, the convolutions of which are separated from one another by means of any suitable insulating material. On the surface of this secondary wire a switch, preferably formed of a number of flat strips of metal superposed, makes a shifting contact. 2 claims.